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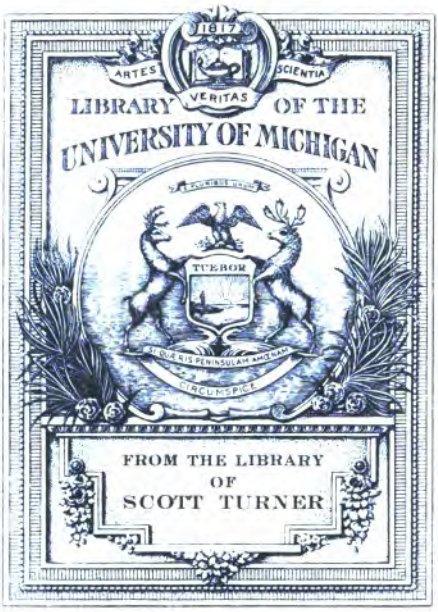

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DEPARTMENT OF THE INTERIOR—U. S. GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

THE PRODUCTION OF COPPER IN 1910

See Mineral Mine on Pg 245

By B. S. BUTLER

ADVANCE CHAPTER FROM MINERAL RESOURCES OF THE UNITED STATES
CALENDAR YEAR 1910

WASHINGTON
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PREFATORY NOTE.

The following account of copper production and trade in 1910 is a part of the annual report on the gold, silver, copper, lead, and zinc industries in the United States. For the sake of convenience and for distribution in advance of the final volume, the general report has been divided into several sections. Wherever in the present section on the production of copper reference is made to the accounts of mine production or to the reviews of other metals, it is to be understood that these other sections of the general report are indicated.

The full report on the industries of gold, silver, copper, lead, and zinc embraces the following sections:

Gold and silver (general report);
Copper (smelter production);
Lead (smelter production);
Zinc (smelter production);
Gold, silver, copper, lead, and zinc in the Western States (mine production);
Silver, copper, lead, and zinc in the Central States (mine production);
Gold, silver, copper, lead, and zinc in the Eastern States (mine production).

The first, second, third, and fourth sections give summary reviews of the respective industries, together with general statistics based on returns from mints, refineries, and smelters; the fifth, sixth, and seventh sections also give reviews of the industries with special reference to States and the details of mining districts and the production of each metal but based on reports made directly to the Survey from the mines.

Each of these sections is published as a separate pamphlet and may be obtained by addressing a request to the Director of the United States Geological Survey, Washington, D. C.

COPPER.

By B. S. Butler.

INTRODUCTION.

In the production of metallic copper suitable for commercial purposes three distinct processes are usually required, namely, mining, smelting, and refining. The Lake Superior native copper district is the only important producer where these three processes are not entirely distinct. It is possible, therefore, to ascertain the copper output of the country by collecting statistics from the mines, from the smelters, and from the refineries, and each of these sets of figures has its advantages and its disadvantages. The mine figures have the advantage of giving the most accurate distribution of the production, but are less accurate in total quantity of copper recovered; the smelter figures permit of reasonably accurate distribution and also furnish the actual recovery of copper from the ores treated during the year; the refinery figures furnish the best measure of the copper made available for commercial uses during the year, but at this stage of manufacture the accurate distribution to the State of origin, or even the separation of copper derived from domestic and from foreign sources, is uncertain.

Statistics for 1910 showing the production of each of these stages of manufacture have been collected by the United States Geological Survey, and are presented in the following report.

Since the same material passes through the three processes of manufacture at successive periods, usually requiring two to three months from the time it is taken from the mine before it reaches the stage of refined copper, the year's production as recorded for the different stages does not represent the same materials—that is, the refinery production for the calendar year 1910 represents the mine production from about October 1, 1909, to October 1, 1910. The three sets of figures representing the successive stages of manufacture do not therefore necessarily agree, although they should not differ greatly if the condition of the industry is normal. The mine and the smelter figures will differ by the difference in the quantity of ore, matte, etc., in stock at the beginning and at the end of the year, and by the difference in the quantity of copper reported by the mines and that recovered by the smelters. This difference is due to the fact that considerable copper is recovered from sulphur, lead, zinc, and siliceous ores carrying values in copper so low that the mines do not receive pay for and frequently do not report the copper content

of the ore, although it is eventually recovered by the smelters. The smelter and refinery figures will differ by the increase or decrease in stock of blister, etc., at the beginning and at the end of the year, and by the loss in refining.

Since the smelter production permits reasonably accurate distribution as to source by States and also gives the actual output of copper, it is adopted in this report as the production of the country. It is made up of the production of blister copper and of furnace-refined or ingot copper of the Lake district.

SUMMARY OF STATISTICS.

The following statistical statement summarizes the copper industry in the United States in 1909 and 1910:

Summary of statistics of the copper industry in the United States in 1909 and 1910.

	1909	1910
Production of copper:		
Smelter output.....pounds..	1,092,951,624	1,080,159,509
Mine production.....do....	1,126,521,126	1,088,237,432
Refinery production of new copper—		
Electrolytic.....do....	778,808,910	782,171,204
Lake.....do....	227,005,923	221,462,984
Casting.....do....	59,750,088	68,260,688
Total domestic.....do....	1,065,564,921	1,071,894,876
Total domestic and foreign.....do....	1,391,021,454	1,422,039,135
Total new and old copper.....do....	1,480,467,686	1,610,000,000
Total ore treated.....short tons..	28,025,092	28,517,556
Copper ore treated.....do....	27,932,618	28,497,123
Average yield of copper.....per cent..	1.98	1.88
Imports.....pounds..	321,801,114	344,435,771
Exports.....do....	682,846,725	708,316,543
Consumption:		
Total new copper.....do....	688,000,000	732,400,000
Total new and old copper.....do....	778,011,473	941,400,000
World's production.....do....	1,873,404,407	1,903,297,003
Value of production in the United States.....	$142,083,711	$137,180,257

Production of copper in the United States in 1909 and 1910.

[Smelter output, in pounds fine.]

	1909	1910		1909	1910
Alaska	4,057,142	4,311,026	Philippine Islands		1,781
Arizona	291,110,298	297,250,538	South Dakota	41,988	43
California	53,568,708	45,760,200	Tennessee	19,207,747	16,691,777
Colorado	11,485,631	9,307,497	Texas	3,456	2,961
Georgia		724	Utah	101,241,114	125,185,455
Idaho	7,096,132	6,877,515	Vermont		1,935
Michigan	227,005,923	221,462,984	Virginia	231,971	105,313
Montana	314,858,291	283,078,473	Washington	120,611	65,021
Nevada	53,849,281	64,494,640	Wyoming	433,672	217,127
New Hampshire	88,944	12,409	Missouri and unapportioned	2,159,636	603,570
New Mexico	5,031,136	3,784,609			
North Carolina	120,451	181,263	Total	1,092,951,624	1,080,159,509
Oregon	245,403	22,022			
Pennsylvania	994,089	740,626			

GENERAL CONDITION OF INDUSTRY.

The year 1910, like the preceding year, was one of prosperity for the copper industry. The smelter output was but slightly less than that of 1909 and exceeded that of any year but 1909. The output of the refineries was the largest in the history of the industry.

The output from both mines and smelters for the year would normally have exceeded that of 1909, as both the mines and the reduction plants were in a position to make a record output; but toward the middle of the year it became evident that the production of copper was exceeding the consumption, and a general policy of curtailment was inaugurated by the mining companies. This curtailment, however, did not affect the refinery output notably until after the close of the year.

No large new producers were added during the year, though a few companies that had been idle in 1909 made a small production. The development of ore and the preparation for production were actively carried on by several companies that will enter the producing list in 1911 and later. Among the more important of these were the companies in the Miami and Ray districts, Arizona; the Santa Rita district, New Mexico; the Yerington district, Nevada; the Lake Superior district, Michigan; and the Copper River district, Alaska.

Both domestic consumption and export of refined copper were the largest in the history of the industry, but were not sufficient to equal the producing capacity of the country. The most essential factor to the prosperity of the industry is an increase in the consumption of refined copper. This is necessary, not that the price may be advanced materially, but in order that the additional copper supplied by the new producers, both domestic and foreign, may be absorbed and yet the old companies may operate their plants at full capacity. Most of the large producers of the country can make copper at a substantial profit at the prices prevailing for the last three years if they are able to operate their plants at maximum capacity and thus avail themselves of every opportunity to reduce the cost of production. It is evident that if copper is to be produced at the minimum cost there must be an increase in consumption that will permit all producers to operate at full capacity, or a part of the plants must close in order that the remainder may operate at maximum capacity and lowest cost. The closing of a part of the plants, however, is not feasible without a general merger of the copper industry, since many of the higher cost producers, the ones that would normally be closed, are operating old mines with extensive developments that must be worked or abandoned, as the cost of pumping, repairs, etc., with the mine idle would be prohibitive.

The consumption of copper has been on the increase, and it is probable that with the continuance of the relatively low price it will be used for some purposes, such as construction, etc., far more extensively than it has been in the past. Any important increase in the use of the metal outside of the industries for which it is essential must depend, however, upon a relatively low cost. It therefore appears that a marked increase in the price of copper can not be expected unless there is a curtailment of production, as the uses for which the metal is now employed do not demand a quantity equal to the maximum capacity of the producing plants. The continuance of a

relatively low price, however, should lead to increased uses of the metal and permit a larger production at lower cost, and possibly with as great or greater profit to the producers.

The average price of copper for 1910, which was 12.7 cents per pound, was the lowest since 1902, but was not far below the average for the last 25 years, as may be seen by referring to the diagram (fig. 1) showing the variations in price since 1860.

The cost of production in 1910 was probably as low as it has been in recent years, and it would have been still lower if the plants had been operated at maximum capacity. One of the most striking features of the industry during the last three years has been the continued decrease in the cost of production. Companies whose copper cost in excess of 15 cents per pound in 1907 produced at a profit in 1910, with copper averaging 12.7 cents per pound, and the new companies that have become producers in the last three years report low cost of production.

Considerable copper was produced at a loss during the year, but such was also the case in 1906 and 1907, when the average price per pound was 19 and 20 cents, respectively. Most of the large producing companies were able to show a profit with a curtailed output; many of them had in preparation or already in operation additional economies which, with a maximum output, will result in lowering the cost of production still further.

The most important event in the copper industry for the last two years has been the consolidation of companies in several of the large copper districts. Among the more important of these consolidations may be mentioned that of the Amalgamated interests and the Clark copper properties of Butte, Mont., under the Anaconda Copper Mining Co.; in the same district, the East Butte Copper Co. absorbed the interests of the Pittsburg & Montana Copper Co. and the Pittsmont smelter. In the Lake Superior district, Michigan, the Calumet & Hecla Mining Co. purchased the Bigelow interests, and a consolidation of most of the companies affiliated with the Calumet & Hecla Mining Co. was under consideration at the close of 1910. In the Bingham district, Utah, the Utah Copper Co. absorbed the Boston Consolidated Copper Co. and later acquired other mineral land; it also acquired a controlling interest in the Nevada Consolidated Copper Co. In the Ely district, Nevada, the Nevada Consolidated Copper Co. absorbed the Cumberland-Ely Copper Co. and the Steptoe Valley Smelting Co., and, as already stated, a controlling interest in the Nevada Consolidated Copper Co. was acquired by the Utah Copper Co. In the Bisbee district, Arizona, a merger of the Calumet & Arizona Copper Co. and the Superior & Pittsburg Copper Co. was effected early in 1911. In the Ray district, Arizona, the Ray Consolidated Copper Co. acquired the property of the Gila Copper Co., and another merger in the district is contemplated. Other mergers of less importance have been effected in the different districts and still others are under consideration.

Most of these mergers have been brought about with the idea of increasing the efficiency of operation and of lowering the cost of production, and these ends have generally been attained. The copper output of the country is now controlled by a few groups of interests and in view of the adverse decisions rendered by the United States Supreme Court in the cases of the Standard Oil Co. and the

American Tobacco Co., it seems doubtful if further centralization of these groups will be attempted, though such a result is desired in some quarters.

A factor of increasing importance to the copper industry is the output of secondary copper. During 1910 the quantity of copper that had been used and returned to the industry in the form of old scrap was equal to about 17 per cent of the total consumption of new copper in the United States and was exceeded in amount by the individual output of new copper by only three States, Arizona, Montana, and Michigan. It is to be expected that there will be an increase in the quantity of copper recovered from scrap that will have a general relation to the increase in consumption in the past.

GEOLOGICAL CLASSIFICATION OF COPPER DEPOSITS.

BASIS OF CLASSIFICATION.

The geological classification of copper deposits is of interest as well as the metallurgical classification. From a statistical standpoint, such a classification is somewhat difficult for the reason that in a single district two or more types may occur and in some instances the amount of copper derived from each has not been recorded. The approximate amount derived from the several types can, however, usually be ascertained.

It is apparent that from a statistical standpoint only broad groups can be recognized as the data are not available for ascertaining the output from types of minor commercial importance, although they may be of great scientific interest.

A classification may be made on the basis of the geologic age of the deposits which is usually the same for all deposits in a given district, which method groups together deposits differing greatly in mineralogical character and geologic occurrence; or, on the other hand, a classification may be based on geologic occurrence and mineralogical character, by which method deposits of widely separated ages are thrown into the same group.

CLASSIFICATION ACCORDING TO GEOLOGIC AGE.

Lindgren[1] has given an age classification of metalliferous ores to which the copper deposits of the United States of known age may be readily referred, although unfortunately there are some of the deposits whose age has not been positively determined.

In varying quantity copper minerals are of widespread and general occurrence both in geographic distribution and in geologic age. It is doubtful if there has been an important period of deposition of metallic minerals, with the exception of iron ores, in which copper minerals have not been deposited to a greater or less extent. In spite of this very universal distribution of the metal, all the deposits of known age that have made important contributions to the country's output can be referred to four periods which in general correspond to periods of igneous activity.

Pre-Cambrian periods.—The pre-Cambrian, covering as it does a very long portion of geologic time, probably includes deposits formed

[1] Lindgren, Waldemar, Metallogenetic epochs, Econ. Geology, vol. 4, 1909, p. 409.

at widely separated times and certainly of wide geographic distribution and of very different character. The important deposits of this age that have been developed to the present time are, however, few in number. The larger producers have been the Lake Superior district of Michigan, the Jerome district of Arizona, and the Encampment district of Wyoming; some lesser deposits in the West and possibly some of the Appalachian deposits should be classed with them. Deposits of this age have yielded approximately 35 per cent of the total output of the country.

Paleozoic era.—The deposits of this era are confined to the Appalachian region. They were formerly considered to be of pre-Cambrian age, but it is now known that several of the Appalachian deposits occur in metamorphosed sediments of early or middle Paleozoic age, and it is probable that the same age will be shown for the inclosing rock of more of them. The time in the Paleozoic when the deposits were formed is somewhat uncertain. Some of them have been described by geologists as being formed before the great period of regional metamorphism which is believed to have occurred in the late Paleozoic; other investigators in studying other deposits have found that the ores were formed after the period of metamorphism. From these descriptions one is led to the conclusion that deposition of copper ore both preceded the regional metamorphism and also followed it. As the data are not now available for a separation of these depositions, they will be considered together—and, indeed, it may be found that most of the deposits were formed during the period of metamorphism. The most important production has been made from the Ducktown district of Tennessee, the Great Gossan lead of Virginia and North Carolina, the Virgilina district of Virginia and North Carolina, and the Ely district of Vermont. Deposits of this age have yielded between 1.5 and 2 per cent of the output of the country.

Mesozoic era.—The third important period of copper deposition occurred in the Mesozoic era, preceding the main deposition of Cretaceous sediments and probably at about the close of the Jurassic or in the early Cretaceous. These deposits are associated with the great masses of monzonitic and dioritic intrusives that extend through the far Western States from British Columbia on the north to Mexico on the south.

Among the more important of these deposits are those of the Shasta district and the "Foothills" district of California, together with numerous districts of Idaho, eastern Washington, and western Nevada, which have not made important production, and the deposits in Alaska. To this general period are assigned the deposits of the Bisbee district, Arizona. Ransome considers that the deposits at Globe, Ariz., are probably of this age, though the field evidence is not conclusive and they may prove to be of the same age as the very similar deposits at Morenci, Ariz., and Santa Rita, N. Mex. It is probable that the deposits of the Ray district and possibly of the Silverbell district, Arizona, will prove to be of the same age as the deposits at Globe. The deposits of the Ely district, Nevada, may be included with these, though it seems quite as probable that they will prove to be of later age.

If the deposits enumerated above are correctly assigned, the output from ores of this age amounts to about 15 per cent of the total.

Tertiary period.—The fourth important period of copper deposition occurred in Tertiary time and was associated with the extensive granitic and monzonitic intrusions in the Rocky Mountain and eastern Great Basin regions extending from Montana on the north to Mexico on the south. The exact age of these intrusions and the associated ore deposits can not always be fixed, but the intrusives cut Cretaceous rocks and in some instances Miocene rocks, and it is probable that the deposits are from early to middle Tertiary in age.

To this period are assigned the deposits of Butte, Mont., of the Morenci-Metcalf district, Arizona, of the Santa Rita district, New Mexico, and probably the deposits of the Bingham and Frisco districts, Utah, together with many deposits of mixed lead-silver-copper ores in Colorado, Utah, and New Mexico that have yielded considerable copper. If the age assigned to the deposits included in this period is correct, ores of this age have yielded about 46 per cent of the total output of the country, and so far as indicated by past and present production it was the most important of the epochs of copper deposition.

Other periods.—In addition to these deposits and periods mentioned there are deposits along the Pacific coast associated with basic igneous rocks of early Mesozoic age. These deposits have not yielded important quantities of copper. In the east the copper deposits associated with the Triassic traps may be mentioned, though the copper derived from them is unimportant. There is a widespread occurrence of what Lindgren has designated "Cretaceous and later concentrations in sedimentary rocks." Deposits of this character occur largely in the "Red Beds" in Arizona, New Mexico, Utah, Colorado, and Texas, and although they have been of little commercial importance in the past there is a possibility of their proving a source of production at some future time.

A little copper has been produced from deposits of late Tertiary age in the Great Basin, but deposits of this age have been of small importance as copper producers within the United States.

CLASSIFICATION ACCORDING TO OCCURRENCE.

From the standpoint of mineral composition and geologic occurrence, the copper deposits may be grouped into six principal classes and the approximate amount derived from each group may be ascertained. In a general way, this grouping also classifies the ores according to the metallurgical treatment to which they are best adapted.

In a classification of this kind that is adapted to a general statistical treatment, it is apparent that too fine distinctions can not be drawn, since the necessary data are not available, and in some districts where copper has been derived from more than one type of deposit it is not possible to obtain exact figures of the output of each. Moreover, even in a very general classification, there is uncertainty in the case of some deposits as to which type they should be assigned.

The following grouping is presented as of interest from a statistical standpoint but is not suggested as an adequate classification of copper ores where data are available for greater refinement:

Lenticular deposits in schistose and igneous rocks.—Under this head are considered deposits whose primary mineralization consisted mainly of sulphide of iron, copper, and zinc, replacing schistose rocks.

The schistosity may be either the result of regional metamorphism or of the local shearing of igneous rocks. This class of deposit usually has a more or less lenticular form. The primary ores are generally a rather low-grade smelting ore but are susceptible of cheap mining and metallurgical treatment. In many instances the upper part of these deposits contain a zone of enriched sulphides. To this type may be referred the deposits of the Jerome district, Arizona; the "Foothill" and Shasta County districts, California; the Ducktown district, Tennessee; many smaller deposits in the Appalachian region, including deposits in New Hampshire, Vermont, Virginia, Alabama, and Georgia, and the deposits of the Prince William Sound district, Alaska. The output from this type of deposit has been about 8.5 per cent of the total from the country; in 1910 it was about 9.5 per cent.

Native copper in volcanic flows.—Under this type are grouped deposits in which the copper occurs native in irregular ore shoots in certain beds of volcanic or interbedded volcanic and sedimentary rocks. The ores are nearly all of a concentrating grade, the metal resulting from the concentration being subjected to a special refining process. The Lake Superior district, Michigan, is the only one of this type that has made important production, though similar deposits occur in Pennsylvania, Maryland, New Jersey, and Alaska. The output from this type is essentially that of the Lake Superior district. It has contributed 31.1 per cent of the total output and 20.5 per cent of the production in 1910.

Replacement deposits in sedimentary rocks.—Under this heading are included what are commonly known as contact deposits and deposits formed by the replacement of sediments along fissures. The primary mineralization in this type consists of iron and copper sulphides, together with varying amounts of other sulphides usually replacing limestone or other highly calcareous rocks. Secondary alteration has frequently been extensive in these deposits and much of the copper has been derived from oxidized ores. Most of the ores are of smelting grade. Some of the oxidized ores carry high copper values, and the primary sulphide ores, though relatively low in copper content, are cheaply treated. To this type of deposit may be referred the output of the Bisbee, Globe, and Silverbell districts, and part of the Morenci-Metcalf district, Arizona; part of the production from Bingham, Utah; Santa Rita, N. Mex.; Ely, Nev.; southeastern Alaska, and many smaller districts. To this type also belongs the output from many lead-silver districts in which copper is of minor importance. Among these are Leadville, Colo., Tintic and Park City, Utah, and many others.

The output from this type of ore has been approximately 18 per cent of the total and about 22.5 per cent of the production in 1910.

Disseminated deposits.—Under this type are considered deposits in which the ore minerals occur in small veins or grains disseminated through altered igneous, schistose, or sedimentary rocks. This includes what are frequently referred to as "porphyry ores." The term disseminated is preferable, since many of the ores of this type do not occur in porphyritic rocks.

The primary mineralization commonly consists of pyrite and chalcopyrite with varying quantities of other sulphides. The deposits have usually undergone secondary sulphide enrichment, the copper content of the minerals near the surface being taken in solution and rede-

posited, usually as chalcocite, on the sulphides lower down. In some instances deposits of this type that have not been enriched are worked, and in still others native copper and cuprite are among the important ore minerals. The ore is usually low-grade concentrating ore but is cheaply mined and milled.

Any separation of this type from that of fissure vein deposits must be purely arbitrary, but it seems desirable to make such a separation. The principal deposits of this type are those of the Bingham and Frisco districts, Utah; Ely district, Nevada; Morenci-Metcalf, Miami, and Ray districts, Arizona; Santa Rita, N. Mex., and others that may prove of future importance. The output from this type of deposit, which has been produced largely during the last five years, is approximately 5.5 per cent of the total and about 20 per cent of the production in 1910.

Fissure vein deposits.—Under this type are included deposits formed in fissure veins and as a replacement along such veins. As already stated, there is no sharp line between this type and that of the disseminated deposits. In the case of the principal deposits of this type, those at Butte, Mont., much of the ore is of a smelting grade, and there are other differences that make it desirable to keep it separate from the disseminated deposits. The primary mineralization of this class consists of sulphides of iron, copper, and zinc in varying amounts, with small amounts of other sulphides filling fissures and replacing the wall rocks. Secondary enrichment in this type as in the preceding has been important in producing the commercial ore. The ores are of both smelting and concentrating grades.

The great deposit of this type is that at Butte, Mont., though smaller deposits occur in many places in the West and to some extent in the Appalachian region. The output from this type is approximately 35 per cent of the total and about 26.5 per cent of the production in 1910.

Disseminated deposits in sedimentary rocks.—To the classes named should be added the disseminated deposits in little altered or unaltered sedimentary rocks, usually referred to as the "Red Beds" deposits. In this class the primary mineralization ordinarily consists of chalcocite disseminated through sandstones, shale, and conglomerate. This may be partly or entirely altered to carbonates, oxides, and silicates. This type has not yielded important amounts of copper in this country, but the deposits are numerous, especially in Texas, New Mexico, Arizona, Colorado, and Utah, and they may prove of commercial importance at some future time.

PRODUCTION.

SMELTER AND MINE PRODUCTION.

GENERAL STATEMENT.

The production of copper in 1910 by smelters from copper-bearing materials from the United States was 1,080,159,509 pounds, valued at $137,180,257,[1] as compared with 1,092,951,624 pounds, valued at $142,083,711, in 1909. The production for 1910 was surpassed by the record production of 1909 only, and falls short of the 1909 production by 12,792,115 pounds, or 1.2 per cent.

[1] For discussion of prices see section on prices on a subsequent page.

The yearly production of copper in the United States from 1845 to 1910, inclusive, together with the actual and relative changes from each preceding year, is shown in the following table:

Magnitude and growth of copper production in the United States from 1845 to 1910, inclusive.

Year.	Production.	Increase.		Average annual increase by decades.	
	Pounds.	*Pounds.*	*Per cent.*	*Pounds.*	*Per cent.*
1845	224,000				
1846	336,000	112,000	50.0		
1847	672,000	336,000	100.0		
1848	1,120,000	448,000	67.0	246,400	50.0
1849	1,568,000	448,000	40.0		
1850	1,456,000	a 112,000	a 7.1		
1851	2,016,000	560,000	38.4		
1852	2,464,000	448,000	22.2		
1853	4,480,000	2,016,000	81.8		
1854	5,040,000	560,000	12.5		
1855	6,720,000	1,730,000	33.3		
1856	8,960,000	2,240,000	33.3	1,472,200	28.5
1857	10,752,000	1,792,000	20.0		
1858	12,320,000	1,568,000	14.6		
1859	14,112,000	1,792,000	14.5		
1860	16,128,000	2,016,000	14.3		
1861	16,800,000	672,000	4.1		
1862	21,160,000	4,360,000	26.0		
1863	19,040,000	a 2,120,000	10.0		
1864	17,920,000	a 1,120,000	a 5.9		
1865	19,040,000	1,120,000	6.3		
1866	19,936,000	896,000	4.7	1,209,600	6.2
1867	22,400,000	2,464,000	12.3		
1868	25,984,000	3,584,000	16.0		
1869	28,000,000	2,016,000	7.7		
1870	28,224,000	224,000	.8		
1871	29,120,000	896,000	3.2		
1872	28,000,000	a 1,120,000	a 3.8		
1873	34,720,000	6,720,000	24.0		
1874	39,200,000	4,480,000	12.9		
1875	40,320,000	1,120,000	2.9		
1876	42,560,000	2,240,000	5.6	3,225,600	8.2
1877	47,040,000	4,480,000	10.		
1878	48,160,000	1,120,000	2.4		
1879	51,520,000	3,360,000	7.0		
1880	60,480,000	8,960,000	17.4		
1881	71,680,000	11,200,000	18.5		
1882	90,646,232	8,966,232	12.5		
1883	115,526,053	24,886,221	27.4		
1884	144,946,653	29,420,600	25.5		
1885	165,875,766	20,929,113	14.4		
1886	156,735,381	a 9,140,385	a 5.5	18,928,949	14.8
1887	180,920,524	24,185,143	15.4		
1888	226,361,466	45,440,942	25.0		
1889	226,775,962	414,496	.2		
1890	259,763,092	32,987,130	14.5		
1891	284,121,764	24,358,672	9.4		
1892	344,998,679	60,876,915	21.4		
1893	329,354,398	a 15,644,281	a 4.5		
1894	354,188,374	24,833,976	7.5		
1895	380,613,404	26,425,030	7.4		
1896	460,061,430	79,448,026	20.0	34,635,407	9.4
1897	494,078,274	34,016,844	7.4		
1898	526,512,987	32,434,713	6.6		
1899	568,666,921	42,153,934	8.0		
1900	606,117,166	37,450,245	6.6		
1901	602,072,519	a 4,044,647	a .7		
1902	659,508,644	57,436,125	9.5		
1903	698,044,517	38,535,873	5.8		
1904	812,537,267	114,492,750	16.4		
1905	901,907,843	89,370,576	11.0		
1906	917,805,682	a 15,897,839	1.7	47,404,234	6.1
1907	868,996,491	a 48,809,191	a 5.3		
1908	942,570,721	73,574,230	8.4		
1909	1,092,951,624	150,380,903	15.9		
1910	1,080,159,509	a 12,792,115	a 1.2		
Total	15,292,491,343				

a Decrease.

The figures, except for 1910, are taken from the previous volumes of Mineral Resources of the United States. Statistics from 1882 to 1910, inclusive, are based on the returns to the United States Geological Survey by the copper-producing companies. Figures for the years prior to 1882 were compiled by the survey from the best sources available. Reliable figures for years previous to 1845 are not obtainable. The year 1845, however, marks the entrance of the Lake Superior district into the ranks of producers and is really the beginning of important production of copper in this country. The industry has shown a steady and, since 1880 when Arizona and Montana became important producers, a very rapid growth. The rate

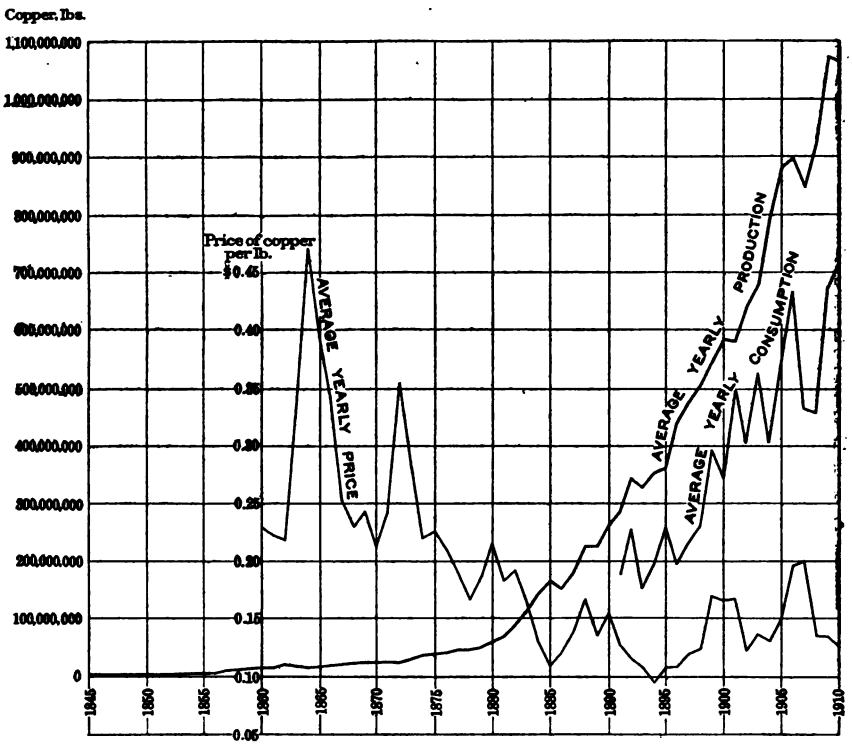

FIGURE 1.—Curve showing production of copper in the United States 1845–1910.

of increase is well shown by the curve showing production from 1845 to 1910 (fig. 1).

Only five times since 1880 has the annual production shown a decrease from that of the preceding year and in every instance the decrease has been slight and has been more than recovered the following year. The years showing a decrease are 1886, 1893, 1901, 1907, and 1910. At several other times the increase has been slight. In most instances where there has been a decrease it may be attributed to a general condition of financial and business depression which has resulted in a decrease in the demand for copper and other materials necessary to the expansion of industries. In two instances a slight decrease appears to have been due to the fact that the producing capacity of the country had been increased out of proportion to the

demand for domestic consumption and export and a temporary curtailment in production became necessary to permit the absorption of accumulated stocks. This, coupled with attempts at artificial control of prices, appears to have been the case in 1886 and also in 1901. The decreases in 1893 and in 1907, which were the most pronounced in the history of the industry, were, of course, due to the widespread condition of financial and business depression of those years. The decrease in production in 1910 can be attributed to the great increase in the producing capacity of this and other countries during the last few years, which has outstripped the normal growth in consumption; though for the last two years both domestic consumption and exports have been the largest in the history of the industry. This excessive production resulted in 1910 in the accumulation of large stocks of copper in various stages of manufacture, which it was found necessary to reduce by curtailing the current production. With the absorption of this excess a continued increase in production is to be expected.

SMELTER RETURNS.

The figures of smelter production for 1910 are based on returns made confidentially to the Geological Survey by all known smelting companies handling copper-bearing materials from the United States. To all companies and officials who have aided in furnishing this information and have given valuable time to answering inquiries to secure the accurate distribution of the output, sincere thanks are extended. The following list gives the names of the owning or operating companies, the location, and the final copper product of smelting and refining plants treating material from the United States during 1910. It does not include lead and zinc plants that recovered copper as a by-product from mixed ores. Lists of lead and zinc smelters can be found in the reports on those metals.

Copper smelting plants that treated materials from the United States in 1910.

Location.	Company.	Final copper product.
UNITED STATES.		
Arizona:		
Clifton	Arizona Copper Co	Blister.
Do	Shannon Copper Co	Do.
Douglas	Calumet and Arizona Mining Co	Do.
Do	Copper Queen Consolidated Mining Co	Do.
Globe	Old Dominion Copper Mining & Smelting Co	Do.
Humboldt	Consolidated Arizona Smelting Co	Do.
Jerome	United Verde Copper Co	Do.
Johnson	Arizona United Mining Co	Matte.
Morenci	Detroit Copper Mining Co	Blister.
Sasco	Southern Arizona Smelting Co	Do.
Swansea	Clara Consolidated Gold & Copper Co	Do.
California:		
Campo Seco	Penn Chemical Works	Matte.
Winthrop	Bully Hill Copper Mining & Smelting Co	Do.
Coram	First National Copper Co	Blister.
Kennett	Mammoth Copper Mining Co	Do.
Martinez	Mountain Copper Co	Do.
Do	General Chemical Co. of California	Matte.
Needles	Needles Smelting & Refining Co	Do.
Colorado:		
Denver	Boston & Colorado Smelting Co	Do.
Utah Junction	Modern Smelting & Refining Co	Do.
Maryland: Baltimore	Baltimore Copper Smelting & Rolling Co. [a]	Electrolytic.

[a] Subsidiary of American Smelters Securities Co.

Copper smelting plants that treated materials from the United States in 1910—Continued.

Location.	Company.	Final copper product.
UNITED STATES—continued.		
Michigan:		
Hancock	Lake Superior Smelting Co	Anodes and lake.
Do	Quincy Mining Co	Do.
Houghton	Michigan Smelting Co	Do.
Hubbell	Calumet & Hecla Mining Co	Do.
Montana:		
Anaconda	Washoe Copper Co	Blister.
Butte	Colusa-Parrot Mining & Smelting Co	Do.
Do	East Butte Copper Mining Co	Do.
Great Falls	Boston & Montana Consolidated Copper & Silver Mining Co.	Blister and electrolytic.
Nebraska: Omaha	American Smelting & Refining Co	Blister.
Nevada: McGill	Steptoe Valley Mining & Smelting Co	Do.
New Jersey: [a]		
Chrome	United States Metals Refining Co	Electrolytic and casting.
Maurer	American Smelting & Refining Co	Electrolytic.
Newark	Balbach Smelting & Refining Co	Electrolytic and casting.
Perth Amboy	Raritan Copper Works	Electrolytic.
New York:		
Black Rock	Buffalo Smelting Works	Lake and electrolytic.
Laurel Hill	Nichols Copper Co	Electrolytic and casting.
Tennessee:		
Copperhill	Tennessee Copper Co	Blister.
Isabella	Ducktown Sulphur, Copper, & Iron Co. (Ltd.).	Matte.
Texas: El Paso	American Smelting & Refining Co	Do.
Utah:		
Bingham	Yampa Smelting Co	Blister and matte.
Garfield	Garfield Smelting Co. [b]	Do.
International	International Smelting & Refining Co	Do.
Virginia: West Norfolk	Virginia Smelting Co	Matte.
Washington:		
Northport	Northport Smelting & Refining Co	Do.
Tacoma	Tacoma Smelting Co. [b]	Blister.
CANADA.		
British Columbia:		
Ladysmith	Tyee Copper Co. (Ltd.)	Matte.
Grand Forks	Granby Consolidated Mining, Smelting & Power Co.	Blister.
MEXICO.		
Aguas Calientes: Aguas Calientes.	American Smelting & Refining Co	Do.

[a] This list does not include a smelter in New Jersey and one in Pennsylvania, both of which make blister from material solely of foreign origin.
[b] Subsidiary of American Smelters Securities Co.

During the year 48 copper smelting and refining plants treated material from the United States. Of these, 45 were domestic plants and 3 were foreign, 2 located in British Columbia and 1 in Mexico. Three plants produced in 1910 that were not operated in 1909, namely, the Clara Consolidated Gold & Copper Co., at Swansea, Ariz.; the Consolidated Arizona Smelting Co., at Humboldt, Ariz.; and the International Smelting & Refining Co., at International, Utah. Six small plants that were operated in 1909 were not active in 1910, making a decrease of three in the number of plants active in 1910.

The figures of production represent the actual smelter recovery. For Michigan it is the sum of furnace-refined copper and copper cast into anodes for electrolytic refining. In the case of blister copper the figures represent the fine copper content. Some casting copper is produced direct from ore and matte and this is included in the smelter production.

The following table shows approximately the production of blister copper from different sections. Smelters that produced only matte are not included in this distribution:

Production of copper in 1910, apportioned according to locality in which smelted to blister, in pounds.

Locality.	Domestic.	Foreign.	Total.
Arizona	295,107,256	22,717,800	317,825,056
Montana	288,625,834	.....	288,625,834
Utah and Nevada	185,717,042	.....	185,717,042
California and Washington	44,599,966	13,189,617	57,789,583
All others	257,853,412	58,877,637	316,731,049
Total by domestic plants	1,071,903,510	94,785,054	1,166,688,564
Total by foreign plants from domestic ore and matte	8,255,999	.....	.....
Grand total from domestic ores	1,080,159,509	.....	.....

As will be seen by comparing this table with the table showing the production by States and districts, ore, with few exceptions, is reduced to blister copper before being shipped from the district. The exceptions in the case of important producing States are Michigan and Colorado. In the case of Michigan the shipping product is high-grade concentrate transported by Lake boats to Buffalo at a low cost; in the case of Colorado the copper is largely produced in lead furnaces and is shipped to Omaha for conversion. Considerable matte produced in California is shipped to the east for conversion.

Arizona treated considerable Mexican ore, and ore and matte from British Columbia were treated in this country. Considerable matte from the United States was smelted in Mexico, and ore from the United States was smelted in British Columbia and returned to this country. A large tonnage of ore and matte from foreign sources was treated by the seaboard smelters.

During 1910 matte smelters produced a total of about 41,250,000 pounds of copper, as compared with 45,100,000 pounds produced in 1909. In most instances the product of these plants is shipped to near-by blister smelters for conversion.

MINE RETURNS.

The figures of mine production are based on reports furnished to the United States Geological Survey by all mines producing copper in 1910. These mines reported 1,088,237,432 pounds of copper, or 8,077,923 pounds more than the smelters. The mines and smelters of the large copper producers are, with few exceptions, under the same management and their production is thought to be reported on the same basis. In the case of mines that ship to custom smelters or have only matting furnaces and ship their matte for conversion there is likely to be considerable discrepancy, as the mines may report a considerable quantity that has not reached the stage of blister by the close of the year and is consequently not included in the smelter production, or material that was reported by the mines in one year may be treated by the smelters the following year. This discrepancy is more pronounced if a marked curtailment of production occurs at the beginning or at the close of the year, so that there is not the bal-

ance of overlap that occurs if the industry is in normal condition throughout the year. A number of operators report the copper in their ores and concentrates on the basis of assay content, in which case it exceeds the smelter recovery from the same material by the amount lost in smelting. Considerable copper is recovered by the smelters from ores that are treated primarily for other metals, the copper content being so low that it is not paid for, and consequently is not always reported by the mines.

The following table shows the output of copper from domestic ores for the last five years as reported by the mines, smelters, and refineries:

Production of copper from domestic ores as reported by the mines, the smelters, and the refineries, 1906–1910, in pounds.

Year.	Mine.	Smelter.	Refinery.
1906	916,971,387	917,805,682	887,682,387
1907	847,151,015	868,996,491	784,271,427
1908	956,840,578	942,570,721	919,111,414
1909	1,126,521,126	1,092,951,624	1,065,564,921
1910	1,088,237,432	1,080,159,509	1,071,894,876
Total	4,935,721,538	4,902,484,025	4,728,535,005

As shown by this table, in the period of five years the quantity of copper reported by the mines exceeded that reported by the smelters by 33,237,513 pounds, or 0.71 per cent. This difference can be accounted for very largely if not entirely by an increase in stocks of ore and concentrates at the smelting plants. At the beginning of the period there was an urgent demand for copper, and the smelters and refineries were turning out the final product as rapidly as possible, only such stocks being carried as were actually necessary. At the close of the period the demand for refined copper was much less active, and many of the smelting companies were carrying considerable reserve stocks of ore and concentrates.

The difference between the smelter and the refinery production is accounted for entirely by an increase in the stocks of blister copper plus the copper content of bluestone produced and the loss in refining.

It appears that although theoretically the output reported by the mines should be considerably in excess of that reported by the smelters, this difference in the last five years has been nearly balanced by the copper recovered from lead, zinc, gold, silver, and sulphur ores which carry copper values so low that they are not paid for and consequently have not usually been reported by the mines.

PRODUCTION BY STATES.

Twenty-four States and Territories contributed to the copper production of 1910. The following table shows the mine and the smelter output of individual States for 1909 and 1910.

According to smelter returns, the three leading States, Arizona, Montana, and Michigan, produced 74 per cent of the total output of 1910, as compared with 76 per cent in 1909; the six leading States, including Utah, Nevada, and California, produced over 96 per cent of the total output in 1910, as compared with over 95 per cent in 1909.

Production of copper by smelter returns in 1909 and 1910, compared with mine returns for same years, by States, in pounds.

State.	1910				1909	
	Production.				Production.	
	Rank.	Percentage of total.	Smelter returns.	Mine returns.	Smelter returns.	Mine returns.
Alaska	10	0.40	4,311,026	4,241,689	4,057,142	4,124,705
Arizona	1	27.52	297,250,538	297,491,151	291,110,298	303,899,461
California	6	4.23	45,760,200	48,700,756	53,568,708	57,288,281
Colorado	8	.86	9,307,497	8,359,535	11,485,631	10,922,046
Georgia	23	.....	724	.....	.....	.....
Idaho	9	.64	6,877,515	7,037,292	7,096,132	9,115,489
Michigan	3	20.50	221,462,984	222,683,461	227,005,923	234,136,529
Montana	2	26.21	283,078,473	284,808,553	314,858,291	312,058,011
Nevada	5	5.97	64,494,640	64,359,398	53,849,281	57,976,477
New Hampshire	19	.....	12,409	12,409	88,944	.....
New Mexico	11	.35	3,784,609	4,614,386	5,031,136	5,393,146
North Carolina	15	.02	181,263	140,514	120,451	224,514
Oregon	18	.....	22,022	13,861	245,403	235,000
Pennsylvania	12	.07	740,626	927,360	994,089	[a] 698,745
Philippine Islands	22	.....	1,781	.....	.....	.....
South Dakota	24	.....	43	.....	41,988	[b] 122,270
Tennessee	7	1.54	16,691,777	16,837,727	19,207,747	19,206,806
Texas	20	.....	2,961	3,157	3,456	.....
Utah	4	11.59	125,185,455	127,597,072	101,241,114	108,947,811
Vermont	21	.....	1,935	.....	.....	.....
Virginia	16	.01	105,313	5,402	231,971	224,162
Washington	17	.01	65,021	86,918	120,611	255,134
Wyoming	14	.02	217,127	222,339	433,672	492,539
Missouri and unapportioned	13	.06	603,570	94,452	2,159,636	1,200,000
Total	.....	.....	1,080,159,509	1,088,237,432	1,092,951,624	1,126,521,126

[a] Includes New Hampshire and Maryland. [b] Includes Alabama, South Carolina, and Texas.

In the distribution of the blister output to the States of origin it is necessary to have reports not only from blister producers but also from matte smelters, as the matte is credited by the smelter that converts it to the State from which it was received, although the matte smelter may have received its ores from several States. In the adjustment of the products of these matte smelters slight errors in the distribution of the blister production are probably introduced.

The following table shows the production from 1845 to 1910 for each State for which separate statistics are available. The statistics from 1882 to 1910 are compiled from reports made by the producing companies to the United States Geological Survey. Prior to 1882, the statistics for individual States have been compiled from the best sources available, and although they are not comparable with the later statistics in accuracy, they are believed to represent approximately the output of the individual States. The totals for the United States prior to 1882 are taken from compilations made in previous volumes of Mineral Resources.

Production of copper in the United States, 1845–1909, by States, in pounds.

State.	1845	1846	1847	1848	1849	1850
Michigan	26,880	58,240	477,120	1,032,640	1,505,280	1,281,280
Eastern States and unapportioned	197,120	277,760	194,880	87,360	62,720	174,720
Total	224,000	336,000	672,000	1,120,000	1,568,000	1,456,000

Production of copper in the United States, 1845–1909, by States, in pounds—Continued.

State.	1851	1852	1853	1854	1855
Michigan	1,744,960	1,774,080	2,905,280	4,074,560	5,808,320
Eastern States and unapportioned	271,040	689,920	1,574,720	965.440	911,680
Total	2,016,000	2,464,000	4,480,000	5,040,000	6,720,000

State.	1856	1857	1858	1859	1860
Michigan	8,211,840	9,531,200	9,157,120	8,926,400	12,069,120
Eastern States and unapportioned	748,160	1,220,800	3,162,880	5,185,600	4,058,880
Total	8,960,000	10,752,000	12,320,000	14,112,000	16,128,000

State.	1861	1862	1863	1864	1865
Arizona		80,000			
California		2,600,000	2,200,000	4,800,000	3,600,000
Michigan	15,037,120	13,585,600	12,985,280	12,490,240	14,358,400
New Mexico	[a] 1,000,000				
Eastern States and unapportioned	762,880	4,894,400	3,854,720	629,760	1,081,600
Total	16,800,000	21,160,000	19,040,000	17,920,000	19,040,000

State.	1866	1867	1868	1869	1870
Arizona		984,000			
California	2,600,000	1,400,000	1,300,000	575,000	55,000
Colorado	112,000				
Idaho				9,000	
Michigan	13,749,120	17,525,760	20,935,040	26,624,640	24,622,080
Montana			4,000	8,000	
New Mexico					12,600
Eastern States and unapportioned	3,474,880	2,490,240	3,744,960	783,360	3,534,320
Total	19,936,000	22,400,000	25,984,000	28,000,000	28,224,000

State.	1871	1872	1873	1874	1875
Arizona		840,000		450,000	500,000
California	600,000	350,000	450,000	320,000	
Colorado				500,000	400,000
Idaho					
Michigan	26,748,080	24,552,640	30,089,920	34,332,480	36,039,360
Montana			100,000		100,000
New Mexico			32,000	50,000	300,000
Nevada			144,000	370,000	
Utah		450,000	875,000	150,000	130,000
Eastern States and unapportioned	1,771,920	1,807,360	3,029,080	3,027,520	2,850,640
Total	29,120,000	28,000,000	34,720,000	39,200,000	40,320,000

State.	1876	1877	1878	1879	1880
Arizona	500,000	3,000,000	3,000,000	3,183,750	2,000,000
California		500,000	400,000	512,000	1,000,000
Colorado	500,000	600,000		1,578	
Michigan	38,370,300	39,025,280	39,690,560	42,848,960	49,738,960
Montana	520,000	400,000	350,000	500,000	1,212,000
New Mexico	308,000			4,055	
Nevada				134,730	
Utah	157,000				
Eastern States and unapportioned	2,204,700	3,514,720	4,719,440	4,334,927	6,531,040
Total	42,560,000	47,040,000	48,160,000	51,520,000	60,480,000

[a] Comprises period 1858–1861, inclusive.

Production of copper in the United States, 1845–1909, by States, in pounds—Continued.

State.	1881	1882	1883	1884	1885
Arizona	8,000,000	17,984,415	23,874,963	26,734,345	22,706,366
California	500,000	836,695	1,600,892	876,166	449,028
Colorado[a]	1,750,000	1,494,000	1,152,652	2,013,125	1,146,460
Idaho				46,667	40,381
Michigan	53,573,120	56,982,765	59,702,404	69,353,202	72,148,172
Montana	1,450,000	9,058,284	24,664,346	43,093,054	67,797,864
New Mexico	500,000	869,498	823,511	59,450	79,839
Nevada		350,000	288,077	100,000	8,871
Utah		605,880	341,885	265,526	126,199
Washington					
Wyoming		100,000	962,468		
Eastern States and unapportioned	5,906,880				
Eastern States		1,555,000	612,124	904,423	211,602
Southern States		400,000	395,175	317,711	40,199
Middle States		294,695	324,706	232,114	190,641
Lead desilverizers and unapportioned		125,000	782,880	950,870	910,144
Total	71,680,000	90,646,232	115,526,053	144,946,653	165,875,766

State.	1886	1887	1888	1889	1890
Arizona	15,657,035	17,720,462	31,797,100	31,586,185	34,796,689
California	430,210	1,600,660	1,570,021	151,505	23,347
Colorado[a]	409,806	2,012,027	1,621,100	1,170,053	3,585,691
Idaho			50,000	156,190	87,243
Michigan	79,890,798	75,471,890	86,472,084	88,175,975	101,410,277
Montana	57,611,621	78,099,677	97,897,968	98,222,444	112,980,896
New Mexico	558,385	283,664	1,631,271	3,686,137	850,034
Nevada	50,000		50,000	26,420	
Utah	500,000	2,500,000	2,131,047	65,467	1,006,636
Washington					
Wyoming			232,819	100,000	
Eastern States	315,719	200,000	271,631	72,000	
Southern States	29,811		18,201	18,144	378,840
Middle States					
Lead desilverizers and unapportioned	1,282,496	2,432,804	2,618,074	3,345,442	4,643,439
Total	156,735,381	180,920,524	226,361,466	226,775,962	259,763,092

State.	1891	1892	1893	1894	1895
Arizona	39,873,279	38,436,099	43,902,824	44,514,894	47,953,553
California	3,397,405	2,980,944	239,682	120,000	218,332
Colorado[a]	6,336,878	7,593,674	7,695,826	6,481,413	6,079,243
Idaho	146,825	226,000	36,367		1,425,914
Michigan	114,222,709	123,198,460	112,605,078	114,306,870	129,330,749
Montana	112,063,320	163,206,128	155,209,133	183,072,756	190,172,150
New Mexico	1,233,197	1,188,796	280,742	31,884	143,719
Nevada			20,000		
Utah	1,562,098	2,209,428	1,135,330	1,147,570	2,184,708
Washington			39,785		
Wyoming					
Eastern States					
Southern States	296,463	467,448	732,793	2,374,514	3,105,036
Middle States					
Lead desilverizers and unapportioned	4,989,590	5,491,702	7,456,838	2,136,473	
Total	284,121,764	344,998,679	329,354,398	354,188,374	380,613,404

[a] For several of the early years the production credited to Colorado includes the yield from some ores of uncertain origin which were smelted in Colorado plants.

Production of copper in the United States, 1845–1909, by States, in pounds—Continued.

State.	1896	1897	1898	1899	1900
Arizona	72,934,927	81,530,735	111,158,246	133,054,860	118,317,764
California	690,237	11,987,772	16,925,634	26,221,897	28,511,225
Colorado [a]	6,022,176	11,873,033	16,274,561	11,643,008	7,826,949
Idaho		183,277	1,266,920	110,000	290,163
Michigan	143,524,069	145,282,059	158,491,703	147,400,338	145,461,498
Montana	221,918,179	230,288,141	206,173,157	225,126,855	270,738,489
New Mexico	2,701,664	701,892	1,592,371	3,935,441	4,169,409
Nevada			437,396	556,775	407,535
South Dakota		2,440,338	1,261,393	17,020	15,147
Utah	3,502,012	3,919,010	3,750,000	9,584,746	18,354,726
Wyoming			233,044	3,104,827	4,203,776
Eastern States	4,704,993	4,472,017	5,395,226	4,410,554	4,820,495
Southern States					
Middle States					
Lead desilverizers and unapportioned	4,063,173	[b] 1,400,000	3,553,336	[b] 3,500,000	[b] 3,000,000
Total	460,061,430	494,078,274	526,512,987	568,666,921	606,117,166

State.	1901	1902	1903	1904	1905
Alaska			1,339,590	2,043,586	4,900,866
Arizona	130,778,611	119,944,944	147,648,271	191,602,958	235,908,150
California	33,667,456	25,638,724	17,776,756	28,520,023	16,697,489
Colorado	9,801,783	8,422,030	4,158,368	9,506,944	9,404,830
Idaho	480,511	227,500	778,906	2,158,858	7,321,585
Michigan	156,289,481	170,609,228	192,400,577	208,309,130	230,287,992
Montana	229,870,415	288,903,820	272,555,854	298,314,804	314,750,582
New Mexico	9,629,884	6,614,961	7,300,832	5,368,666	5,334,192
Nevada	593,608	164,301	[a] 150,000		413,202
Oregon					846,615
South Dakota	753,510	445,663	173,202	[a] 100,000	38
Utah	20,116,979	23,939,901	38,302,602	47,062,889	58,153,393
Washington		209,297	80,758	663,604	223,328
Wyoming	2,698,712	889,228	1,023,189	3,565,629	2,530,531
Eastern States	6,860,039	13,599,047	13,855,612	15,211,086	15,134,960
Southern States					
Middle States					
Lead desilverizers and unapportioned	531,530	[b] 500,000	[b] 500,000	[b] 100,000	
Total	602,072,519	659,508,644	698,044,517	812,537,267	901,907,843

State.	1906	1907	1908	1909	1910
Alaska	8,685,646	7,034,763	4,438,336	4,057,142	4,311,026
Arizona	262,566,103	256,778,437	289,523,267	291,110,298	297,250,538
California	28,153,202	33,696,602	39,643,335	53,568,708	45,760,200
Colorado	7,427,253	13,998,496	13,943,878	11,485,631	9,307,497
Idaho	8,578,046	9,707,299	7,256,086	7,096,132	6,877,515
Michigan	229,695,730	219,131,503	222,289,584	227,005,923	221,462,984
Montana	294,701,252	224,263,789	252,503,651	314,858,291	283,078,473
New Mexico	7,099,342	10,140,140	4,991,351	5,031,136	3,784,609
Nevada	1,090,435	1,998,164	12,241,372	53,849,281	64,494,649
Oregon	545,359	518,694	271,191	245,403	22,022
South Dakota			5,471	41,968	48
Utah	50,329,119	66,418,370	71,370,370	101,241,114	125,185,455
Washington	290,823	122,263	162,201	120,611	65,021
Wyoming	106,177	3,026,004	2,416,197	433,672	217,127
Eastern States and unapportioned	18,535,995	22,161,967	21,513,431	22,806,294	18,342,359
Total	917,805,682	868,996,491	942,570,721	1,092,951,624	1,080,159,509

[a] For several of the early years the production credited to Colorado includes the yield from some ores of uncertain origin which were smelted in Colorado plants.
[b] Based partly on estimates.

Total production by States, 1845–1910, and percentage and rank of each State.

State.	Quantity.	Percentage.	Rank.
	Pounds.		
Alaska	36,811,455	0.24	11
Arizona	3,200,184,268	20.93	3
California	445,134,957	2.91	5
Colorado	203,752,063	1.33	7
Idaho	54,557,684	.36	10
Michigan	4,756,420,142	31.10	2
Montana	5,326,439,393	34.83	1
New Mexico	92,323,163	.60	9
Nevada	137,939,097	.90	8
Oregon	2,449,784	.02	14
South Dakota	5,253,813	.04	13
Utah	658,774,460	4.31	4
Washington	1,977,781	.01	15
Wyoming	25,843,400	.17	12
Eastern States and unapportioned	344,629,883	2.25	6
Total	15,292,491,343	100.00	.....

The totals in the preceding table show the copper output of each important copper-producing State, except those on the Atlantic coast, since the beginning of the industry. Some copper was produced from New Mexico in the early years of the last century, but the exact quantity is not known. It was not large as measured by present production of the metal. A little copper was also produced in Michigan prior to 1845, but it was not sufficient in quantity to be of importance. Considerable copper was produced in the Eastern States prior to 1845.

Under "Eastern States and unapportioned" is included some copper classed as "lead desilverizers, etc." in the earlier reports of the Survey. This should properly be credited to some of the Western States. The output of the Central States, except Michigan, is also included under this head. Statistics for the individual Eastern States have not been compiled, but it may be stated that approximately 211,700,000 pounds has been derived from Tennessee. Of the remainder, Vermont and Virginia have made the largest contributions, and some copper has been produced by practically all of the Appalachian States.

It will be noted that Montana, Michigan, and Arizona stand out as the three great copper-producing States. Montana ranks first, with more than one-third of the entire output of the country; Michigan ranks second, with slightly less than one-third; and Arizona ranks third, with over one-fifth of the total output. Utah, ranking next in order, has produced less than one-twentieth of the total output. The three leading States have produced 86.86 per cent of the entire production.

It will be noted by reference to the table showing the output for 1910 that the three States still maintain their preeminence, producing 81 per cent of the total output in 1908, 76 per cent in 1909, and 74 per cent in 1910. The relative importance of other States, however, is much greater in recent years, Utah producing 11.6 per cent of the total 1910 output. The six leading States in 1910, Arizona, Montana, Michigan, Utah, Nevada, and California, produced 96 per cent of the output for that year. The same States have produced 95 per cent of the total output since 1845.

In the following table is given the blister copper output of the leading districts of the country in 1910:

Blister copper production of principal districts in 1910, in pounds.

District or region.	State.	Approximate smelter output.	Percentage of total production.	Rank.
Butte	Montana	282,500,000	26.16	1
Lake Superior	Michigan	221,400,000	20.5	2
Bisbee	Arizona	142,500,000	13.19	3
Bingham	Utah	112,000,000	10.37	4
Morenci-Metcalf	Arizona	73,100,000	6.76	5
Ely	Nevada	63,200,000	5.85	6
Jerome	Arizona	38,600,000	3.57	7
Shasta County	California	36,000,000	3.33	8
Globe	Arizona	27,600,000	2.56	9
Ducktown	Tennessee	16,700,000	1.55	10
Tintic	Utah	9,000,000	.82	11
Calaveras County	California	8,000,000	.74	12
Silverbell	Arizona	5,700,000	.53	13
Coeur d'Alene	Idaho	5,000,000	.46	14
Courtland	Arizona	4,700,000	.43	15
Leadville	Colorado	3,600,000	.33	16
San Juan-Ouray region	do	2,800,000	.26	17
Santa Rita	New Mexico	2,670,000	.24	18
Prince William Sound	Alaska	2,300,000	.21	19
Southeastern Alaska	do	2,000,000	.19	20
Big Bug	Arizona	2,000,000	.19	21
Total		1,061,370,000	98.24	
All others		18,630,000	1.76	
Grand total		1,080,000,000	100.00	

As shown in this table 21 districts in 1910, as compared with 19 districts in 1909, each produced 2,000,000 or more pounds of blister copper. The 21 districts in 1910 produced more than 98 per cent of the copper output of the country; the 19 districts in 1909 produced 97.5 per cent of the total. In 1910 the 10 leading districts, only one of which yielded less than 20,000,000 pounds, produced nearly 94 per cent of the total output, as compared with 93 per cent in 1909 for the same districts.

The following table shows the output of the principal copper-producing districts of the United States from the beginning of production to the close of 1910. For the later years the statistics are compiled from reports furnished to the United States Geological Survey by the producing companies. For the earlier years the figures are taken mainly from reports on the several districts by members of the Geological Survey.

Total blister copper production of principal districts to the close of 1910, in pounds, and percentage of total and rank of each.

District.	State.	Production began.	Pounds.	Percentage of total production.	Rank.
Butte	Montana	1868	[a] 5,315,000,000	34.75	1
Lake Superior	Michigan	1845	[b] 4,756,000,000	31.10	2
Bisbee	Arizona	1880	[c] 1,285,000,000	8.40	3
Morenci-Metcalf	Arizona	1873	[d] 882,700,000	5.77	4
Jerome	Arizona	1883	[e] 570,000,000	3.72	5
Bingham	Utah	1896	[f] 465,000,000	3.04	6
Shasta County	California	1897	[g] 336,000,000	2.19	7
Globe	Arizona	1881	[h] 334,700,000	2.18	8
Ducktown	Tennessee	1850	[i] 211,700,000	1.38	9
Ely	Nevada	1908	[j] 125,000,000	.81	10
Foothill belt	California	1862	[k] 104,000,000	.68	11
Santa Rita	New Mexico	1800(?)	[l] 103,000,000	.67	12
All others			804,300,000	5.31	
Total			15,292,400,000	100.00	

[a] The output of Montana, from which the estimated production of other districts of the State has been deducted.
[b] The Michigan output is taken from Mineral Resources of the United States.
[c] Production of earlier years has been taken from Prof. Paper U. S. Geol. Survey No. 21, 1904.
[d] Production of earlier years has been taken from Prof. Paper U. S. Geol. Survey No. 43, 1905.
[e] Figures from 1896 to 1910 furnished by the United Verde Copper Co. Output prior to 1896 compiled from Mineral Industry and mining journals.
[f] Production of earlier years has been taken from Prof. Paper U. S. Geol. Survey No. 38, 1905.
[g] Production of earlier years has been taken from Bull. U. S. Geol. Survey No. 430, 1910, p. 75.
[h] Production of earlier years has been taken from Prof. Paper U. S. Geol. Survey No. 12, 1902.
[i] Figures compiled by Prof. W. H. Emmons.
[j] From reports of operating companies to the United States Geological Survey.
[k] Estimated from total output of California.
[l] Early production taken from Prof. Paper U. S. Geol. Survey No. 68, 1910.

Twelve districts situated in eight States have each contributed in excess of 100,000,000 pounds to the copper output of the country. Four of these districts are in Arizona, 2 in California, and 1 each in Montana, Michigan, Nevada, New Mexico, Tennessee, and Utah. Two districts stand out prominently. They are the Butte district, Montana, which has contributed slightly over one-third of the output of the country, and the Lake Superior district, Michigan, with a production of a little less than one-third of the total output. Bisbee, ranking third, has yielded 8.4 per cent of the total production. The 12 districts have yielded 94.69 per cent of the total output of the United States since 1845.

It will be seen by a comparison of the table showing the total output of the leading districts with the table showing the output of the leading districts in 1910 that the first 10 are the same, but that the order is changed to some extent. These districts have yielded 93.34 per cent of the total output and 93.84 per cent of the production of 1910.

It is noteworthy that nearly every one of the leading producing districts has made a record output within the last three years and nearly every one of them could have done so in 1910, so far as the ability of the mines to produce the ore was concerned. An indifferent copper market and metallurgical difficulties, however, resulted in a decrease in the output in 1910 for several of the districts.

It is also noteworthy that there is not a single instance where one of the leading copper districts of the United States, several of which have been active producers for a period of 30 years or more, has been worked out or showed a decrease in its ability to produce copper.

TONNAGE AND YIELD OF COPPER ORES.

COPPER-BEARING ORES PRODUCED IN 1910.

The following tables show the tonnage and the yield in copper of the ores produced by the mines of the United States in 1910. The figures are taken from the mine reports of the various States, which form a part of the volume on Mineral Resources issued annually by the United States Geological Survey. As stated in a preceding paragraph, the close agreement between the output as reported by the mines and the actual recovery of metal by the smelters, when accumulated stocks are considered, leads to the belief that the tenor of ores as reported by the mines is very close to the actual recovery of metal. The classification of some of the complex western ores is a difficult and more or less arbitrary matter. Under copper ores are classed those which contain 2½ per cent or more of copper, as well as those which contain less than this percentage, provided their principal value is in copper. Under copper-lead and copper-zinc ores are classed complex ores in which copper is an important constituent. Considerable copper was reported by the mines from ores mined primarily for other metals, including siliceous gold and silver ores, lead ores, zinc ores, pyritic sulphur ores, and ores concentrated for values in other metals. No attempt has been made to compile tables showing the tonnage and yield of this group of copper-bearing ores, but together with old slags, etc., they yielded a total of 13,846,998 pounds, or about 1 per cent of the total output.

Copper produced in 1910 from ores in which copper constitutes the principal value, by States.

State.	Copper ore.	Copper in ore.	Percentage.	Gold in ore.	Silver in ore.	Value in gold and silver per ton.
	Short tons.	*Pounds.*		*Fine ounces.*	*Fine ounces.*	
Alaska	39,365	4,241,689	5.38	1,764.91	26,388	$1.29
Arizona	3,644,495	296,739,350	4.07	52,707.40	1,934,363	.59
California	716,685	48,672,937	3.39	31,844.68	1,363,668	1.94
Colorado	15,078	1,489,664	4.94	8,961.27	436,358	27.85
Idaho	70,163	5,912,392	4.21	765.80	475,363	3.88
Michigan	10,869,561	222,683,461	1.02	.....	330,500	.01
Montana	4,517,709	283,072,965	3.13	31,441.93	9,153,590	1.24
Nevada	2,375,490	64,151,251	1.35	21,230.87	107,365	.21
New Hampshire	569	12,409	1.09	18.24	476	1.11
New Mexico	55,220	3,961,406	3.58	1,449.41	60,228	1.13
North Carolina	2,221	140,514	3.16	60.66	8,454	2.62
Oregon	68	13,861	10.19	1.98	535	4.85
Pennsylvania	218,183	927,360	.21	272.83	50	.02
Tennessee	552,796	16,837,727	1.52	126.40	81,237	.08
Texas	17	1,740	5.11	1.20	30	2.41
Utah	5,417,558	124,306,847	1.15	113,978.50	2,036,909	.64
Virginia	271	5,402	.99	6.48	128	.75
Washington	819	43,597	2.66	5.39	7,475	5.06
Wyoming	970	222,174	11.45	42.13	1,307	1.62
Total and average	28,497,238	1,073,436,846	1.88	264,680.08	16,024,424	.49

Copper ores concentrated and smelted, concentrates produced, and copper produced from each class of ore in 1910, by States.

State.	Concentrates.				Ores smelted.		
	Ores concentrated.	Concentrates produced.	Copper in concentrates.	Per centage of copper from ore.	Quantity.	Copper produced.	Per centage of copper from ore.
	Short tons.	*Short tons.*	*Pounds.*		*Short tons.*	*Pounds.*	
Alaska					39,365	4,241,689	5.38
Arizona	1,417,602	251,750	59,388,594	2.09	2,226,893	237,350,756	5.33
California	3,031	303	25,882	.426	713,654	48,647,055	3.41
Colorado					15,078	1,489,664	4.94
Idaho	52	13	1,114	1.07	70,111	5,911,278	4.21
Michigan	10,869,561	180,420	222,683,461	1.02			
Montana	3,978,893	1,236,994	221,825,506	2.79	538,816	61,247,459	5.68
Nevada	2,346,354	211,241	62,332,419	1.30	29,136	1,818,832	3.12
New Hampshire					569	12,409	1.09
New Mexico	33,922	1,902	937,454	1.38	21,298	3,023,952	7.09
North Carolina					2,221	140,514	3.163
Oregon					68	13,861	10.19
Pennsylvania					218,183	927,360	.2125
Tennessee					552,796	16,837,727	1.523
Texas					17	1,740	5.11
Utah	4,846,429	181,201	91,975,100	.95	571,129	32,331,747	2.83
Virginia					271	5,402	.9965
Washington					819	43,697	2.66
Wyoming					970	222,174	11.45
Total and average	23,495,844	2,063,824	659,169,530	1.40	5,001,394	414,267,316	4.14

Copper produced from copper-lead and copper-zinc ores in 1910, by States.

State.	Copper-lead and copper-zinc ores.	Copper in ore.	Percentage of copper.
	Short tons.	*Pounds.*	
Arizona	1,193	67,704	2.96
Colorado	2,219	148,049	3.33
Montana	1,524	128,127	4.20
Nevada	385	29,955	3.89
New Mexico	15	1,505	5.00
Utah	14,982	578,250	1.93
Total and average	20,318	953,590	2.34

Copper derived from ore classed as copper-bearing ores (copper, copper-lead, and copper-zinc ores), and total production of copper from all sources in 1910, by States.

State.	Ore treated.	Copper recovered.	Percentage of copper.	Copper from all sources, including old slags, smelter cleanings, precipitates, etc.
	Short tons.	*Pounds.*		*Pounds.*
Alaska	39,365	4,241,689	5.88	4,241,689
Arizona	3,645,688	296,807,054	4.07	[a] 297,491,151
California	716,685	48,672,937	3.39	48,700,756
Colorado	17,297	1,637,713	4.73	[b] 8,359,535
Idaho	70,163	5,912,392	4.21	[c] 7,037,292
Michigan	10,869,561	222,683,461	1.02	222,683,461
Missouri				[d] 94,452
Montana	4,519,233	283,201,092	3.13	[e] 284,808,553
Nevada	2,375,875	64,181,206	1.35	[a] 64,359,398
New Hampshire	569	12,409	1.09	12,409
New Mexico	55,235	3,962,911	3.58	[f] 4,614,386
North Carolina	2,221	140,514	3.16	140,514
Oregon	68	13,861	10.19	13,861
Pennsylvania	218,183	927,360	.212	927,360
Tennessee	552,796	16,837,727	1.52	16,837,727
Texas	17	1,740	5.11	3,157
Utah	5,432,540	124,885,097	1.15	[g] 127,597,072
Virginia	271	5,402	.996	5,402
Washington	819	43,697	2.66	[f] 86,918
Wyoming	970	222,174	11.45	222,339
Total and average	28,517,556	1,074,390,436	1.88	1,088,237,432

[a] Some copper was produced from siliceous and lead ores.
[b] Most of the copper from Colorado is derived from ores classed as siliceous ores and lead ores.
[c] Considerable copper is produced from ores classed as lead ores.
[d] By-product of lead ores.
[e] Considerable copper was produced from zinc and siliceous ores.
[f] Considerable copper was produced from siliceous ores.
[g] Considerable copper was recovered from ores classed as siliceous ores and lead ores.

Copper ores produced in the United States, 1906–1910, by years, in short tons, and average yield in copper, gold, and silver.

Year.	Copper ore.	Yield in copper.	Yield per ton in gold.	Yield per ton in silver.	Value per ton in gold and silver.
	Short tons.	*Per cent.*	*Ounces.*	*Ounces.*	
1906	18,000,000	2.50	0.0150	0.882	$0.856
1907	20,253,000	2.11	.0135	.609	.682
1908	22,290,886	2.07	.0104	.666	.560
1909	27,932,618	1.98	.0097	.655	.540
1910	28,497,238	1.88	.0093	.562	.495

Copper ores produced in the United States, 1906–1910, by years, classified as smelting and concentrating ores, in short tons, and average yield in copper from each.

Year.	Smelting ores.		Concentrating ores.	
	Quantity.	Yield in copper.	Quantity.	Yield in copper.
	Short tons.	*Per cent.*	*Short tons.*	*Per cent.*
1906	3,278,000		14,722,000	
1907	3,957,500	4.05	16,295,500	1.41
1908	4,665,534	4.27	17,760,522	1.485
1909	5,267,707	4.15	22,664,911	1.47
1910	5,001,394	4.14	23,495,844	1.40

TONNAGE.

The output of copper, copper-lead, and copper-zinc ores mined in 1910 was 28,517,556 tons, as compared with 28,025,092 tons in 1909. Of this output 28,497,238 tons were copper ores and 20,318 tons were copper-lead and copper-zinc ores, as compared with 27,932,618 tons of copper ores and 92,474 tons of copper-lead and copper-zinc ores in 1909. Of the 28,497,238 tons of copper ores, 5,001,394 tons were smelting ores and 23,495,884 tons were concentrating ores, as compared with 5,267,707 tons of smelting ores and 22,664,911 tons of concentrating ores in 1909. In 1910 concentrating ores produced 2,063,824 tons of concentrates, the average concentration being 11.3 into 1, as compared with 9.7 into 1 in 1909 and with 10.8 into 1 in 1908. Excluding the ores and concentrates from Michigan, 12,626,283 tons of ore produced 2,150,429 tons of concentrates, or a concentration of about 6.7 into 1, as compared with 5.6 into 1 for 1909.

It is seen by reference to the tables showing the production of ores for the last five years that there has been an increase of over 50 per cent in the tonnage mined since 1906. The actual increase, of course, is most in concentrating ores, though the relative increase in this type is not very much greater than in the crude smelting ores. The output of smelting ores has increased about 52 per cent, and that of concentrating ores has increased about 60 per cent. Michigan, with 10,869,561 tons, was by far the largest producer of copper ores in 1910, and was followed in order by Utah, Montana, Arizona, Nevada, California, and Tennessee. In the output of smelting ores the States were in the following order: Arizona, California, Utah, Tennessee, and Montana; in the output of concentrating ores Michigan was first, followed in order by Utah, Montana, Nevada, and Arizona.

YIELD.

The 28,517,556 tons of copper, copper-lead, and copper-zinc ores mined in 1910 contained 1,074,390,436 pounds of recoverable copper, or an average of 1.88 per cent, as compared with 1.98 per cent for 1909 and with 2.08 per cent for 1908. If the Michigan output is excluded, the yield of the remaining copper ores was 2.41 per cent in 1910, as compared with 2.63 per cent in 1909 and with 2.98 per cent in 1908.

In 1910 copper ores produced 1,073,436,846 pounds of copper, or an average yield of 1.88 per cent copper, and copper-lead and copper-zinc ores produced 953,590 pounds, or an average yield of 2.34 per cent copper. The 5,001,394 tons of smelting ore yielded 414,267,316 pounds of copper, or an average of 4.14 per cent, as compared with 4.15 per cent for 1909 and with 4.27 per cent for 1908. The 23,495,844 tons of concentrating ore yielded 659,169,530 pounds, or an average of 1.40 per cent, as compared with 1.47 per cent for 1909 and with 1.48 per cent for 1908. Excluding the ores from Michigan, which yielded an average of 1.02 per cent in 1910, the same as in 1909, the concentrating ores from the remainder of the United States yielded an average of 1.73 per cent, as compared with 1.92 per cent in 1909 and with 2.10 per cent in 1908.

As shown in the table giving yield in copper, gold, and silver, there has been a marked decrease in the tenor of copper ores treated during the last five years, the average yield dropping from 2.50 per cent in

1906 to 1.88 per cent in 1910. The average yield of the smelting and the concentrating ores, considered separately, shows much less change, the decrease in the average of total ores being due largely to an increase in the tonnage of concentrating ores.

Among the important copper-producing States Arizona retained the lead in the yield of copper per ton of ore, the average yield for 1910 being 4.07 per cent; California was second, with a yield of 3.39 per cent; Montana was third, with 3.13 per cent; and Tennessee, Nevada, Utah, and Michigan followed in the order given.

Of the States producing an important tonnage of crude smelting ores, Montana had the highest yield, with an average of 5.68 per cent; Arizona was second, with a yield of 5.33 per cent; and California, Utah, and Tennessee followed, with yields of 3.41, 2.83, and 1.52 per cent, respectively.

In the yield from concentrating ores Montana took first rank with an average of 2.79 per cent, followed by Arizona, with 2.09 per cent; Nevada, 1.30 per cent; Michigan, 1.02 per cent; and Utah, 0.95 per cent.

In 1910 copper ores yielded 264,680.08 ounces of gold and 16,024,424 ounces of silver, or an average of 0.0093 ounce of gold and 0.562 ounce silver per ton. The total value of the gold and silver content of copper ores was $14,124,509, an average precious-metal value of 49.5 cents per ton. In 1909 copper ores yielded 0.00975 ounce gold and 0.655 ounce silver per ton, an average precious-metal value of 54 cents per ton. Exclusive of that portion of the Michigan ores from which the silver was not recovered, the average precious-metal content was 73.8 cents per ton of ore, as compared with 83.4 cents in 1909 and with 91 cents in 1908.

Exclusive of the Michigan ores that did not yield silver, there was still included considerable ore from which the gold and silver values were not recovered, namely, that producing the casting copper from the Morenci-Metcalf district, Arizona, and from the Ducktown district, Tennessee, and to a slight extent from other districts. This casting copper was not electrolytically refined, and consequently the precious-metal values were not recovered from it.

Among the important copper-producing States California was first in the value of gold and silver per ton of copper ore, the average being $1.94; Montana followed with an average of $1.24; Utah with $0.64; Arizona, $0.59; Nevada, $0.21; Tennessee, $0.08; and Michigan, $0.01.

REVIEW BY STATES.

INTRODUCTORY STATEMENT.

In the following pages a brief statement of the conditions affecting production in the principal districts of the country is presented, the geologic occurrence of the ores is briefly summarized, and the tenor of ore from each district is given when this will not disclose the production of individual companies, the figures of whose output have not already been published in their annual report or elsewhere.

Those desiring more detailed information of the mining operations of the districts are referred to the reports on mine production for the various States, which have been published by the United States Geological Survey and which, with this and other reports, form the

first part of the volume Mineral Resources of the United States for 1910.

The accompanying map (Plate I, in pocket) shows the location of the districts that have contributed to any important extent to the output of copper during the last three years. Unfortunately, such a limitation in time excludes some districts which contain valuable copper deposits but which were not producers during the period covered, and on the other hand it includes districts that will probably never be of importance and yet which have produced during the specified period.

The period of the last three years has been taken in order to exclude many small districts and plants that were operated during the "boom times" of 1906 and 1907, but which will never be of permanent importance as copper producers. The symbol showing the relative output of the principal camps from the beginning of production must also be correctly read and not be interpreted as representing the present relative importance of the various districts or in any way to represent the possibilities of those districts. Several districts that show very poorly on total relative output were important contributors in 1910, and still others whose relative output is not represented will be important producers in a short time.

In the case of a few districts making an important output in the early days it has not been possible to get even a close approximation of their total production, and consequently their relative importance could not be shown.

The actual figures upon which the relative output is based will be found in the table showing the production of the principal districts and in the description of the individual districts. The present relative importance of the several districts can be ascertained by consulting the table showing the output of the principal districts for 1910.

The list of reduction plants accompanying the map includes all copper smelters and refineries operated during the last three years, though several of these are no longer in operation, and it also includes copper smelting plants in process of construction during 1910.

ALASKA.

The blister copper production from Alaska in 1910 was 4,311,026 pounds, as compared with 4,057,142 pounds in 1909.

Important production began in Alaska in 1903 and it reached its maximum production of 8,685,646 pounds in 1906. Since the fall in the price of copper in 1907, the Alaska production has been much less. The total output to the close of 1910 has been 36,811,455 pounds. With the entrance of the Copper River district into the producing list and increased activity in the Prince William Sound district, the output for 1911 should show a material increase. The output for 1910 as in previous years was from the Ketchikan and the Prince William Sound districts.

Ketchikan district.—The Ketchikan district yielded about 2,000,000 pounds of blister copper in 1910, as compared with about 2,700,000 pounds in 1909. The deposits of the district[1] thus far developed are

[1] For detailed descriptions see Wright, C. W., and Paige, S., Mineral resources of Alaska in 1907: Bull. U. S. Geol. Survey No. 345, 1908, pp. 98–115; and Wright, F. E., and Wright, C. W., Ketchikan and Wrangell mining districts, Alaska: Bull. U. S. Geol. Survey No. 347, 1908.

of contact origin, the ores run high in iron, being composed of pyrrhotite, magnetite, pyrite, and chalcopyrite and are a desirable ore for the British Columbia and Washington smelters. Neither of the smelting plants in the district was in operation during 1910, the ores being shipped to the Ladysmith and the Tacoma smelters. Only the relatively high-grade ores are shipped, as the low-grade materal can not be marketed profitably at the present price of copper. The average yield in copper is between 4 and 5 per cent, and the ores carry rather low values in gold and silver.

Prince William Sound district.—The Prince William Sound district produced about 2,300,000 pounds of blister copper in 1910, a distinct increase over the production of 1909. The principal output was from Latouche Island, the Beatson Bonanza mine being the largest producer. During the year the property passed into the hands of the Guggenheim-Morgan interests and plans for an increased output were inaugurated. The ores of the district were shipped to the Tacoma smelter, only the relatively high-grade ore being shipped. The deposits [1] consist of pyrrhotite, chalcopyrite, and pyrite, with minor amounts of other sulphides occurring in sheer zones in or closely associated with greenstone.

Copper River district.—No production was made from the Copper River district during 1910, but work was continued on the Copper River and Northeastern Railroad which reached the Bonanza mine in the spring of 1911, when ore shipments began, the first train load of ore leaving the mine on April 6.

To the close of 1910 the Bonanza mine was the only deposit developed in the district that promises to make important production in the near future. This mine, the property of the Kennicott Mines Co., controlled by the Guggenheim-Morgan interests, is situated near the head of Bonanza Creek near Kennicott Glacier.

The primary ores [2] are principally chalcocite with some bornite, replacing limestone near a greenstone contact. These minerals have been partly altered to carbonates at the surface. This is one of the few copper deposits known in which chalcocite, the principal ore mineral, is regarded as a primary mineral. Much of the ore is almost pure chalcocite and is very high grade. The district should make a considerable production of copper during 1911.

ARIZONA.

In 1910 Arizona produced 297,250,538 pounds of blister copper, as compared with 291,110,298 pounds in 1909. This is the largest output in the history of the Territory and again gives Arizona first rank among the copper-producing States, a place lost to Montana in 1909. With the added output of new producers in 1911, Arizona will doubtless maintain her supremacy as a copper producer for many years.

The steady output of copper from Arizona began about 1875, though there was intermittent production prior to that date, the earliest record of production being for 1862. Since 1880 the growth of the industry has been steady and rapid. To the close of 1910, Arizona had a recorded production of 3,200,184,268 pounds

[1] Grant, U. S., and Higgins, D. F., Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska: Bull. U. S. Geol. Survey No. 443, 1910, pp. 87–96.
[2] Moffit, F. H., and Maddren, A. G., Mineral resources of Kotsina-Chitina region, Alaska: Bull. U. S. Geol. Survey No. 374, 1909.

of copper, or 20.93 per cent of the total output of the country, thus giving the Territory third rank among the copper-producing States. The Territory produced 27.52 per cent of the total output of the country for 1910.

Eleven copper-smelting plants operated within the Territory during the year.

The greater part of the production, as in previous years, was from four districts, though two other important districts were nearly ready to enter the producing class at the close of the year.

Bisbee district.—The Bisbee, or Warren, district in southern Cochise County, was the largest producer, with about 142,500,000 pounds of blister copper, as compared with 130,000,000 pounds in 1909. This was the largest output in the history of the district. Production began in 1880, since which time it has been a constant and increasingly important contributor to the output of copper. To the close of 1910 it had produced 1,285,000,000 pounds of copper, or 8.4 per cent of the output of the country and 39.3 per cent of the Arizona production. In total and in present output it ranks third among the copper districts of the country.

The Paleozoic [1] sediments of the district have been faulted and fissured and granite porphyry has been intruded in the form of stocks, dikes, and sills. The Sacramento Hill stock is the most prominent body of granite porphyry in the district, but in the mine workings dikes and sills of the porphyry are found extending into the limestones, and in the southern part of the district the porphyry masses are probably not directly connected with the Sacramento Hill mass, though both were doubtless derived from the same source. The ores occur replacing the limestone closely associated with the granite porphyry bodies, and also replacing the limestone along faults and fissures. So close is the association of ore and porphyry that in recent years prospecting has been guided to a considerable extent by this association. The presence of amphibole, pyroxene, garnet, vesuvianite, etc., associated with the ore minerals indicates a contact metamorphic origin of the ore bodies.

The primary ores are largely cupriferous pyrite carrying low values in copper. The workable ore bodies thus far developed have resulted from the concentration of the copper contained in the primary ores by the process known as "secondary enrichment." Under favorable conditions these secondary changes have extended to great depth. In the upper workings the copper is principally in the form of carbonate oxides and native copper. With increasing depth sulphide ores become relatively more important. The richer ores of the latter class have resulted from the partial replacement of the original ores by the richer secondary copper sulphides. Under favorable conditions, this enrichment has taken place to the greatest depth attained in mining developments.

In the early days the output of copper was entirely from oxidized ores, but in recent years the quantity derived from sulphide ores has rapidly increased and at the present time probably equals that derived from oxidized ores.

[1] For detailed geological report see Ransome, F. L., Geology and ore deposits of the Bisbee quadrangle, Arizona: Prof. Paper U. S. Geol. Survey No. 21, 1904; Rice, Claude T., Camp of Bisbee, Arizona: Mines and Methods, Salt Lake City, Utah, vol. 1, 1909, p. 241.

It is reported by the companies that additions of ore reserves in all the properties have fully equaled or exceeded extraction and in some cases most important developments have been made. This is especially true of the Junction shaft of the Superior & Pittsburg Co., where large bodies of unusually high-grade sulphide ore were developed in the 1,300-foot, 1,400-foot, and 1,500-foot levels. Sulphide ore of fair grade was encountered by this shaft on the 1,700-foot level, but the extent of the deposit has not been ascertained.

The nature of the deposits of the district do not favor the blocking out of extensive ore reserves far in advance of immediate needs, since the cost of keeping the heavy ground open for a long period is prohibitive. The quantity of ore actually blocked out in proportion to the annual output of copper is probably smaller for this district than for any large producing district in the country.

Most of the ore occurs in irregular bodies without definite arrangement, so that the cost of prospecting is greater than in many other districts. Moreover, the soft heavy ground associated with the ore makes it necessary to employ the square set method in mining, and the cost of timber adds materially to the cost of mining. Recently efforts have been made by both of the principal companies to modify their system of mining so as to use less timber. The cost of mining in the district, however, is likely to remain relatively high. Centralization and improvement in the hauling and hoisting systems of the mines has resulted in marked economy. The ores of the district continue to show a decrease in grade, but this is in part due to improvement in mining and metallurgical methods which permit the treatment of lower grade material. It is the policy of most of the companies to mine as low-grade ore as can be treated at a reasonable profit. In the early days of mining in the district the oxidized ores yielded about 20 per cent of copper. For 1910 the average recovery was about 5.43 per cent copper, with 0.0234 ounce gold and 1.07 ounces silver per ton, an average precious metal value of $1.07 per ton of ore.

The Copper Queen mine produced a total of 596,193 tons of ore and precipitate, containing 76,428,908 pounds of copper, 12,430 ounces of gold, and 608,097 ounces of silver.

The Calumet & Arizona mine produced 347,577 tons of ore, the ore as it came from the mine yielding an average of 4.175 per cent copper, which contained $18.93 in gold and silver per ton of refined copper.

The Superior & Pittsburg mine produced 256,490 tons of ore, yielding an average of 5.119 per cent copper as the ores came from the mine. The copper contained $17.98 in gold and silver per ton of refined copper.

The production of ore from the Shattuck-Arizona mine was larger than in previous years. According to the statement by the auditor of the Territory the mine yielded 14,751,000 pounds of copper.

At Douglas the smelting plants of the Copper Queen Consolidated Mining Co. and the Calumet & Arizona Mining Co. were operated throughout the year. Experiments were conducted and plans inaugurated by both companies looking to an increased recovery of flue dust. The Copper Queen Consolidated Mining Co. began the construction of an addition to the smelter to consist of a calcining and reverberatory plant to treat fine ores and flue dust. It will consist of 2 reverberatory furnaces and 6 calciners of the McDougal

type, with the necessary bins to store concentrates, dust chambers, flues, and stacks.

In 1910 in addition to Copper Queen ores, the smelter treated the ores and concentrates of the Montezuma Copper Co., Mexico, and custom ores from Arizona and New Mexico.

The Calumet & Arizona Mining Co., has under consideration the entire remodeling of the old smelting plant or the construction of a new smelter. The increase in the percentage of sulphide ores produced has made a change in the metallurgical treatment of the ores desirable.

The district is served by the El Paso and Southwestern Railroad, controlled by Phelps, Dodge & Co. Oil for fuel is used extensively in the production of power, electric power being generated in central plants and distributed to the points where needed.

Toward the close of the year plans were perfected looking to a merger of the Calumet & Arizona Mining Co. and the Superior & Pittsburg Mining Co. These plans were consummated early in 1911, the stock of the Calumet & Arizona Mining Co. being increased to 650,000 shares and an exchange made for the stock of the Superior & Pittsburg Mining Co. on the basis of 1 share of Calumet & Arizona for 3½ shares of Superior & Pittsburg.

Morenci-Metcalf district.—The deposits of the Morenci-Metcalf district are at Morenci and Metcalf, in Greenlee County. During 1910 the district produced 73,154,000 pounds of blister copper as compared with about 72,000,000 pounds in 1909.

The district was one of the earliest copper producers in the Territory, the output beginning as early as 1873, and since 1880 it has been an important contributor to the copper output of the country. To the close of 1910, a total of 882,700,000 pounds of copper had been produced, or 5.77 per cent of the output of the country since 1845, and 27.58 per cent of the output of the Territory. In total production it ranks fourth among the copper districts of the country and second in the Territory. In the output for 1910 it ranks fifth in the country and second in the Territory.

The copper ores[1] of this district occur as contact deposits in Paleozoic limestones and shales which have been intruded by stocks and dikes of porphyry, as disseminated deposits mainly in the porphyry, and as deposits in fault fissures of the Coronado type.

The original ores were pyrite and chalcopyrite of too low grade to be of economic importance. The workable bodies have resulted from the process of secondary enrichment. The ore bodies in the limestone were formed in certain beds favorable to deposition and this produced roughly tabular bodies nearly parallel to the stratification of the limestone. Alteration of these bodies has produced oxidized ores which formed most of the workable ores in the limestone. These are now nearly exhausted.

The disseminated ores occur in highly altered porphyry adjacent to fissure veins. The copper content of the upper portion of these deposits has been leached and deposited as chalcocite on the pyrite lower down. This has produced a zone of commercial ore, varying in thickness, in general not extending below a depth of 400 feet.

[1] For detailed report of the Clifton-Morenci district see Lindgren, W., The copper deposits of the Clifton-Morenci district, Arizona: Prof. Paper U. S. Geol. Survey No. 43, 1905; Tovote, William L., Min. and Sci. Press, vol. 101, 1910, p. 770.

In the fault fissure or Coronado type of deposit, commercial ore has been developed to much greater depth, and recent exploration of the principal faults in Copper Mountain indicates that commercial ore may be found associated with these faults considerably below the general level of the ore zone.

Of the 1910 copper output, 51,082,689 pounds were derived from concentrating ores, and 22,072,280 pounds from smelting ores. The mines of the district produced 1,306,783 tons of concentrating ores, yielding 1.99 per cent copper, and 247,865 tons of smelting ore, yielding an average of 4.18 per cent copper, the average yield for the 1,554,648 tons of ore produced in the district being 2.35 per cent.

The ores in general carry low gold and silver values, and as much of the copper is of sufficient purity for commercial purposes it is not refined electrolytically, and consequently the precious metal content is not recovered.

Until recently the square set and fill system of mining which necessitated the use of large amounts of timber was very generally employed in the district. More lately modified systems of slicing and caving have been introduced and are being extended, so that at present a large percentage of the ore is extracted by these methods at a considerably reduced cost.

The district contains large reserves of ores, and developments during 1910 have considerably increased the reserves and added to the possibilities of ore in both the Morenci and the Metcalf sections of the district.

The Detroit Copper Co. reduced to bullion 497,250 tons of ore, yielding 23,591,021 pounds of copper, or 46.64 pounds per ton of ore. The average assay value of ore concentrated was 2.977 per cent of copper. An amount equal to 76.42 per cent of the content of the ore was recovered in concentrates. In the smelting and converting of ore and concentrates a recovery of 90.945 per cent of the copper content was made.

During the fiscal year ending September 30, 1910, the Arizona Copper Co. (Ltd.) produced 32,161,205 pounds of copper. The average yield in copper per ton of ore treated was 42.64 pounds, or 2.13 per cent. This compares with a yield of 2.15 per cent for the preceding year. Of the ore mined, 57.6 per cent came from the Longfellow group and 42.4 per cent from the Metcalf group. Of the total ores, 96 per cent were concentrating ores and 4 per cent smelting ores. Of the total copper production, 85 per cent was derived from sulphide ores and 15 per cent from oxidized ores.

For the fiscal year ending August 31, 1910, the smelter of the Shannon Copper Co. produced 16,565,032 pounds of copper from company ores and 1,045,233 pounds from custom ores. During the same period the mines of the company yielded 311,456 tons of ore.

Three smelting plants, those of the Arizona Copper Co. (Ltd.), and the Shannon Copper Co., at Clifton, and of the Detroit Copper Co., at Morenci, were operated during the year. These treated 239,765 tons of smelting ore, yielding 22,072,280 pounds of copper, and 214,933 tons of concentrates, yielding 51,144,045 pounds of copper.

The oxide concentrator of the Arizona Copper Co. (Ltd.) treated a large tonnage of ore and tailings, producing 11.3 per cent of the company's output for the fiscal year.

The district is served by the line of the Arizona and New Mexico Railway Co. controlled by the Arizona Copper Co. A narrow gage line controlled by Phelps, Dodge & Co. extends from Morenci to connect with the Arizona and New Mexico Railroad at Coronado. Early in 1910 the Shannon Copper Co. completed a standard gage road connecting the mines at Metcalf with the concentrating and smelting works at Clifton.

Jerome district.—The Jerome or Verde district of Yavapai County, produced about 38,660,000 pounds of blister copper in 1910, as compared with about 36,700,000 pounds in 1909. The production of copper in the district began about 1883 though it had yielded gold and silver previous to that time. Since 1888 it has been a steady and important producer.

To the close of 1910 it has yielded a total of 570,000,000 pounds of copper, or 3.72 per cent of the total output of the country since 1845, and 17.8 per cent of the total output of the Territory. In total output it stands fifth among the copper districts of the country and third in Arizona. In output for 1910 the district ranks eighth among those of the country and third in the Territory.

According to Graton [1] the ore body of the United Verde mine is an irregular lenticular mass, replacing a schistose rock that has resulted from the intense sheering of a rather basic porphyry. The ore minerals, mainly sulphides of iron, copper, and zinc, have partly or completely replaced the rock in some instances; in others, they occur as veins and stringers in the schist. The ores are of pre-Cambrian age.

The ores differ from most of the large copper deposits of Arizona in carrying rather high gold and silver values. The copper content of the ore is also unusually high for this type of deposit.

As little timber as possible is employed in mining on account of the danger from fire.

Considerable copper is recovered from the mine waters that have leached through the burning stopes by precipitation on scrap iron.

Most of the ore is smelted at the United Verde Copper Co.'s plant. The ore high in sulphur is roasted and smelted in blast furnaces. Some of the ore low in sulphur is smelted without roasting.

It is reported that plans are now under consideration for the remodeling of the present smelting plant or the construction of a new smelter.

According to published figures, the United Verde Copper Co., the only important producer of the district, made an output of 38,663,880 pounds of copper, 563,133 ounces of silver, and 19,267 ounces of gold in 1910. The precious metal content was equivalent to about 1.8 cents per pound of copper.

Development was carried on by other companies in the district during the year, but no important production was made. The district is served by a narrow-gauge railroad owned by the United Verde Copper Co., which connects with the Santa Fe, Prescott & Phoenix Railway.

Globe district.—The Globe district of Gila County produced about 27,600,000 pounds of blister copper in 1910, as compared with about 33,000,000 pounds in 1909.

[1] Graton, L. C., Mineral Resources U. S. for 1907, pt. 1, 1908, p. 597.

Production of copper began in the district about 1881; the camp was well known as a silver producer before that date. For several years subsequent to 1881 the production was intermittent, but since 1888, and especially since 1898 when the railroad reached the camp, the district has ranked among the important copper producers of the country. To the close of 1910 it has produced a total of 334,700,000 pounds of copper, or 2.18 per cent of the output of the country since 1845, and 10.45 per cent of the output of the Territory. In total production the district ranks eighth in the country and fourth in the Territory. For 1910 it ranks ninth in the country and fourth in the Territory.

The geology[1] of the district may be briefly summarized as follows: Paleozoic sediments, consisting of conglomerates, quartzites, shales, and limestones were laid down unconformably on a pre-Cambrian basement of schist and intruded granitic rocks. In post-Paleozoic time the region was invaded by an intrusion of diabase followed by an intrusion of granitic rock. After a period of erosion the area was partly or wholly buried beneath Tertiary volcanic and sedimentary rocks which have since been partly removed by erosion.

The copper deposits are believed to have been introduced at the time of or closely following the post-Paleozoic granitic intrusion, and the source of the copper-bearing solutions is believed to have been connected with this igneous rock. The deposits of the district are of quite different types, dependent largely upon the nature of the rocks in which they were formed. In the Globe end of the district the deposits occur as roughly lenticular deposits replacing limestone, and as fault lodes or fissure zones of quartz and sulphide in diabase.

In the Miami end of the district the ores occur mainly as small veins of quartz and sulphide in the shattered rock near the granite schist contact, the mineralization occurring in both formations.

Most of the ores developed to the present time owe their commercial value to secondary enrichment. The ore extracted from the limestone has been largely oxidized, and much of the ore developed in the diabase has been enriched sulphide. Under favorable conditions the sulphide enrichment has gone on to the greatest depth to which development has extended. Some bodies of primary ore of commercial grade have also been developed.

In the disseminated bodies of the Miami section the original ore was sulphides of iron and copper. The copper content of the ores near the surface has been largely taken into solution and redeposited as chalcocite on the sulphides lower down. The commercial ore consists of grains of pyrite and chalcopyrite partly or wholly replaced by chalcocite. The commercial bodies of ore are blanket-like deposits overlain by leached "sapping" and underlain by primary mineralization too lean in copper content to be classed as commercial ore.

An exceptional type of ore is that of the Black Warrior mine, which is oxidized ore cementing dacite tuff or breccia.

To the present time the main production has been from the Globe end of the district. In the last few years, however, large tonnages

[1] For detailed description see Ransome, F. L., Geology of the Globe copper district, Arizona: Prof. Paper U. S. Geol. Survey No. 12, 1903; Ransome, F. L., Geology at Globe, Arizona: Min. and Sci. Press, vol. 100, 1910, p. 256; Ransome, F. L., Geology of the Globe district, Arizona: Min. and Sci. Press, vol. 102, 1911, p. 747; Tolman, C. F., jr., Min. and Sci. Press, vol. 99, 1909, p. 646; Higgins, Edwin, Eng. and Min. Jour., vol. 89, 1910, pp. 769, 813, 870.

of ore have been developed in the Miami section, and 1911 will see this section an important producer.

The ores of the district vary greatly in copper content, the grade to be treated at any given time depending largely on the possibility of profitable treatment. In general, ores of as low grade as can be handled with reasonable profit are mined. During 1910 the ores yielded about 5 per cent of copper, with about 33 cents in gold and silver per ton. Most of the ore from the district has been of smelting grade. During 1910 about one-third of the ore was concentrated about 3 to 1.

Two smelting plants were operated in the district during the year, the Old Dominion Copper Co.'s smelter, and the matte smelter of the Arizona Commercial Copper Co. The latter plant was closed April 17, 1910, and remained inactive for the remainder of the year.

The district is served by the Gila Valley, Globe & Northern Railway, a branch of the Southern Pacific. This line has been extended from Globe to the Miami district.

The Old Dominion and United Globe mines were the largest producers during the year.

The average copper content of ores mined by the Old Dominion Copper Mining & Smelting Co. was higher than in 1909. In 1910 smelting ores yielded 7.85 per cent copper and concentrating ores yielded 3.49 per cent. The average grade for both was 5.70 per cent, as compared with 4.8 per cent for the preceding year. The total cost of copper per pound was 10.16 cents.

In the United Globe mine extensive additions were made to the developed ore.

Production by the Arizona Commercial Co. ceased with the closing of its smelting plant in April, but development by this and other companies was continued in the Globe end of the district.

The Warrior Development Co., operating the Black Warrior mine, was the only important producer in the Miami end of the district in 1910. According to the company's report, the mine produced 27,320 tons of ore, with an average copper content of 9.66 per cent, yielding 5,295,529 pounds of copper. The ores mined up to the present have been oxidized ores in dacite tuff or breccia.

Development was continued at the Miami Copper Co.'s property. At the close of the year the company reported 18,000,000 tons of developed ore, averaging 2.58 per cent copper. The blocking out of the ore was carried on to the point where the mine was prepared, at the close of the year, to furnish a tonnage of ore equal to the capacity of the mill. The method of extracting the ores consists of a top-slicing and sublevel-stoping system, which has been described in some detail in the articles referred to.

The mill was nearly completed during the year and the first unit went into operation in March, 1911. The mill consists of six units, and has a nominal capacity of 2,000 tons per day, though it is expected that this will be exceeded in actual operation. Concentrates will be shipped to the Cananea Consolidated Copper Co.'s plant at Cananea, Mexico, for smelting.

Development of ore by churn drill and underground openings was continued by the Inspiration Copper Co. At the close of the year the company reported 15,994,000 tons of ore, with a copper content of 2.02 per cent, as fully developed, and 4,195,000 tons, with a copper

content of 1.91 per cent, as partly developed, a total of 20,189,000 tons of developed and partly developed ore, with an average copper content of 1.997 per cent.

The ore is being blocked out preparatory to the employment of a modified form of the caving system in mining. An experimental mill was in operation at the close of the year to determine the best system of concentrating the ores, but definite arrangements for the construction of a mill had not been made.

Development was carried on at the Live Oak, Keystone, and other properties. The Live Oak Copper Co. reported, at the close of the year, 6,000,000 tons of developed ore, averaging 2.25 per cent copper, and 3,000,000 tons of the same grade partly developed.

Silverbell district.—The Silverbell district of Pima County made a production of about 5,750,000 pounds of blister copper in 1910, as compared with about 10,500,000 pounds in 1909.

Important copper production began in the district in 1904, though it had produced some silver and a little copper before that date. At the close of 1910 the district had produced about 41,800,000 pounds of copper.

Paleozoic sediments [1] have been intruded by an acid porphyry, the sedimentary formation for the most part being detached blocks entirely surrounded by porphyry. The copper deposits are of two types—contact deposits, in which the sulphides of iron and copper, together with contact silicates, garnet, epidote, etc., have replaced limestone; and disseminated deposits, in which the original ores consist of iron and copper sulphides as veinlets and small grains in the shattered porphyry. The commercial ores of the latter type in this district, as in most others, have resulted from the secondary enrichment of these deposits.

The ore mined to the present time has been principally that of the contact deposits. These ores are in general rather low-grade smelting ores. However, they are nearly or quite self-fluxing and can be treated cheaply. Development of disseminated ores has been in progress by several companies and encouraging results are reported, but there has been no important output from this type of ore.

The ores of the district are treated at the plant of the Southern Arizona Smelting Co., at Sasco. This plant was closed down August 16, 1910, and remained idle for the rest of the year.

A branch of the Southern Pacific Railroad extends from Red Rock to the district.

The Imperial Copper Co. was the main producer in 1910, as in previous years.

Mineral Creek or Ray district.—Development was continued in the Mineral Creek district, Pinal County, during the year.

This district has not been a large copper producer to the present time, but beginning with 1911 will take its place among the important copper districts of the country. The geology [2] of the district is very similar to that of the Globe district to the north. Paleozoic sediments have been deposited on a basement of pre-Cambrian schists. In post-carboniferous time the region was invaded by an

[1] The district has been briefly described by C. F. Tolman, jr., Min. and Sci. Press, vol. 99, 1909, p. 710.

[2] Ransome, F. L., Geology of the Globe district, Arizona: Min. and Sci. Press, vol. 102, 1911, p. 747; Weed, W. H., The Ray copper mining district, Arizona: Mining World, vol. 34, 1911, p. 53; Tolman, C. F., jr., Disseminated chalcocite deposits at Ray, Arizona: Min. and Sci. Press, vol. 99, 1909, p. 622.

intrusion of diabase and later by a granitic intrusive of varying composition. After a period of erosion the area was buried beneath Tertiary volcanics and sediments. Later it was elevated, faulted, and the covering of Tertiary sediments partly removed. The ore deposits of the district are of two distinct types—those formed in the sedimentary rocks adjacent to faults and fissures, and disseminated deposits in the schist and granite. The ores of both types are believed to have been introduced at the time of and closely following the granitic intrusion.

The deposits of the first type are found east of the Ray fault. The ores are mainly oxidized. To the present time important production has not been made from this type, nor have large ore reserves been developed.

The disseminated deposits occur in crushed schist and granite. The original mineralization was pyrite and chalcopyrite, but the commercial ore has resulted from secondary enrichment of the deposits produced by the leaching of the copper values from the upper portion and redepositing them as chalcocite on the sulphides lower down. This has resulted in a blanket-like deposit of commercial ore covered by a relatively barren capping and underlain by a zone of original mineralization too low in copper content to be of commercial value. Locally, especially associated with the diabase, native copper becomes of some importance.

The district is served by the Arizona & Eastern Railroad. The mines and reduction work are connected by the Ray & Gila Valley Railroad, controlled by the Ray Consolidated Copper Co.

The most extensive operations in the district were conducted by the Ray Consolidated Copper Co., with which the Gila Copper Co. has been merged.

Development of ore by churn-drill methods and blocking out of the ore bodies preparatory to extraction were carried on through the year. On April 1, 1911, the company reported 64,831,000 tons of ore fully developed, and a total of 77,535,000 tons fully and partly developed, having an average copper content of 2.17 per cent. The ore is being blocked out with a view to mining by the "caving" system.

The reduction works of the company are located at Hayden, on the Arizona & Eastern Railroad, about 21 miles from the mine.

The mill will consist of eight units with an approximate capacity of 8,000 tons per day. The first unit of the mill went into operation March 15, 1911, and the remaining units will probably be in operation before the close of the year.

A smelting plant to reduce the concentrates is in process of construction at the same place, but will not be completed for some time. Previous to the completion of the smelter the concentrates will be shipped to El Paso.

Development of ore was carried on by the Ray Central Copper Co., which reported 7,500,000 tons of ore developed January 1, 1911. A test mill was operated by this company for a part of the year, but definite steps toward the erection of a permanent milling plant were not taken. Less extensive operations were carried on by other companies.

Other districts.—The smelter of the Arizona United Copper Co., at Johnson, Cochise County, was active for a part of the year. At

Humboldt, Yavapai County, the smelter of the Consolidated Arizona Smelting Co. was operated the latter part of the year, receiving part of its ores from the United Verde mine. The Clara Consolidated Gold & Copper Mining Co.'s smelter at Swansea, Yuma County, was in blast for a short period. Shipments were continued from the Courtland district, Cochise County, but this district has not proven as productive as was at first hoped. During 1910 it yielded about 2,850,000 pounds of copper.

Several small smelters in the Territory that were active in 1906 and 1907 have been unable to operate since the decline in the price of copper.

CALIFORNIA.

In 1910 California produced 45,760,200 pounds of blister copper, as compared with 53,568,708 pounds for 1909. The reduction in output for the State is due to the necessity of eliminating from the smelter smoke ingredients injurious to vegetation. This resulted in a decreased output by all of the smelters of the Shasta County district and the closing down of one. The same cause will further restrict the output for 1911.

California was among the earliest of the Western States to make an important output of copper. Production began in the "Foothill" belt about 1862 and for several years was an important industry, California being second only to Michigan in its copper production. In a few years, however, the industry declined, and California did not have important rank as a copper producer until 1897, when production from the Shasta County district began. Since that time there has been a steady and important output from the State. The production for the early years has been ascertained from the best sources available, and adding to this the known production since 1882, it is found that to the close of 1910 California has produced about 445,000,000 pounds of copper, or 2.91 per cent of the output of the country since 1845. In 1910 the output was 4.23 per cent of the total production of the United States. In total output the State ranks fifth among the copper producers and for 1910 it ranked sixth.

Seven plants in the State treated copper ores in 1910, though several of these were operated for only a short period, and the two largest plants made reduced outputs.

The main production has come from two districts, though numerous other districts have made small outputs, and copper minerals are widely distributed over the State. The largest producer has been the Shasta County district and the next most important the "Foothill" district.

Shasta district.—The Shasta County copper belt is situated in the Klamath Mountains, at the head of the Sacramento Valley, a few miles north of the town of Redding. Sacramento River crosses the belt, separating it into an eastern and a western portion, the eastern portion containing the Bully Hill and the Afterthought districts; and the western, the Iron Mountain and the Little Backbone districts. Placer mining was carried on in the district in the early days of mining in the State, and later considerable silver was produced from the gossan outcrop of the copper deposits. Although copper minerals have been long known from the district, it was not until 1897, when the Mountain Copper Co. (Ltd.), began production at Iron Mountain,

that it became an important contributor of copper. In 1910 the district produced about 36,000,000 pounds of copper, as compared with about 48,000,000 pounds in 1909. The total production to the close of 1910 has been about 336,000,000 pounds, or about 2.19 per cent of the total output of the country. In 1910 the district produced about 3.33 per cent of the total output. In total output the district ranks seventh, and in the production for 1910 it ranked eighth among the copper districts of the country.

The inclosing rock[1] of most of the ore bodies is an alaskite porphyry intrusive of Mesozoic age. The ore minerals have replaced this rock along zones of shearing. In the western district the ores thus far developed are large, flat lying, more or less tabular bodies of no great vertical extent. In the eastern district they have more the character of veins and, locally, form deposits in the adjoining sediments. The ore in the western district is pyrite, with a small percentage of chalcopyrite and varying amounts of sphalerite. In the eastern district sphalerite becomes an important constituent.

Rich secondary sulphide ores were found underlying the gossan at Iron Mountain and Bully Hill, but these have been exhausted

The ores carry values in precious metals, those of the eastern district being rich in them. The average metal content of ores treated from the district for 1910 was 3 per cent of copper, with 0.0571 ounce gold and 1.78 ounces of silver per ton, a precious metal value of $2.14 per ton. The combined precious-metal content is equivalent to 3.56 cents per pound of copper. A large tonnage of ore is blocked out in the mines of the district.

The producing companies in 1910 were the Mountain Copper, Balaklala, Mammoth, and Bully Hill companies. All of the ore is smelted in the district, except that of the Mountain Copper Co., which during 1910 was treated at its Martinez plant on San Francisco Bay. In addition to local ores, the smelters treated ores from Nevada, Utah, and Oregon, and ore and matte from other districts of the State. A large tonnage of the low-grade gold quartz ores of the districts was used by the smelters of the western district to flux their ores. The pyritic process of smelting is practiced successfully throughout the belt. In the eastern district hot blast is used in the smelting of ores which are high in zinc.

Three smelters were operated in the district during 1910: The Mammoth smelter of the Mammoth Copper Mining Co., at Kennett, the Bully Hill smelter of the Bully Hill Copper Mining and Smelting Co., at De Lamar, and the Balaklala smelter of the First National Copper Co., at Coram.

The smelting plant of the Mammoth Copper Mining Co. was operated throughout the year. In order to remove ingredients of the smelter smoke injurious to vegetation, the Mammoth Co. constructed a bag house similar to the one in operation at the Midvale plant, Utah. This was put into operation July 5, 1910, and is reported to be entirely successful in removing objectionable substances from the smoke, but the capacity permitted the operation of only two of the four furnaces during the summer months. With the addition of fans and sprays

[1] Diller, J. S., Redding folio (No. 138), Geol. Atlas U. S., U. S. Geol. Survey, 1906; Bull. U. S. Geol. Survey No. 213, 1903, pp. 123–132; Bull. U. S. Geol. Survey No. 225, 1904, pp. 169–179. Graton, L. C., The occurrence of copper in Shasta County, Cal.: Bull. U. S. Geol. Survey No. 430, 1910, p. 71.

for cooling the gases, the capacity has been increased so that three furnaces can be operated. At the company's mine 330,633 tons of ore was extracted, and it is reported by the company that a tonnage of ore fully equal to that extracted was developed. The Balaklala Copper Co. installed a Cottrell process plant for clearing the fumes. This process has not proved entirely successful, as the smelting plant could be operated at only part capacity, and even then the fumes were not freed sufficiently from injurious substances to meet the requirements of the court's decree, and the plant was ordered to be closed in July, 1911. It is hoped that the plant may be perfected and accomplish the purpose for which it was designed.

The Bully Hill Co. has not installed a plant for treating the smelter fumes, and consequently was closed in July, 1910. It is reported that the company is conducting experiments with a view of developing a process by which it can treat the ores without injury to vegetation.

In view of the difficulties experienced in handling the smelter-smoke problem, it is not likely that the district will show an increase in production in 1911; in fact, there will likely be a further falling off.

Electric power is used almost exclusively at both mines and smelters.

The district is served by the Southern Pacific Railroad, short branches extending to the smelters. The Iron Mountain district is connected with the main line by a narrow-gauge railroad operated by the Mountain Copper Co., and the mines of the Mammoth Co. are connected with the smelter by a combined electric railroad, gravity tram, and steam railroad. The ores of the Balaklala mine are delivered to the smelter over a cable tramway.

"Foothill" district.—The "Foothill" belt is a rather extensive area of copper deposits which has its best development in Calaveras County. This belt furnished practically the entire copper production from California in the sixties. Following that period of activity, the district was inactive for many years. From 1887 to 1892 the mines made some production. The present period of activity began about 1901, and for some years the district has made important contributions to the copper output of the State.

There is no accurate record of the output of this district in the early days, but from the records of the production of the State it is estimated that to the close of 1910 it has yielded approximately 104,000,000 pounds of copper. The production for 1910 was approximately 8,000,000 pounds. In total output and in production for 1910 the district ranks eleventh among the copper districts of the country.

The ores,[1] consisting of pyrite and chalcopyrite, occur as lenticular bodies replacing schist. The ores vary in different parts of the district from those carrying nearly pure pyrite and chalcopyrite with very low gold and silver content to ores carrying considerable lead, zinc, and precious metal. The ores treated in the district during 1910 averaged about 5.2 per cent in copper, with about 2.3 cents in precious metal per pound of copper.

The matte smelter of the Penn Chemical Co. was operated in the district, and ore was shipped to custom smelters.

[1] Knopf, A., Bull. Dept. Geology Univ. California, vol. 4, p. 411; Read, J. A., Econ. Geology, vol. 2, 1907, p. 380; Lang, Herbert, Eng. and Min. Jour., vol. 84, 1907, p. 909.

COLORADO.

In 1910 Colorado produced 9,307,497 pounds of blister copper, as compared with 11,485,631 pounds in 1909. Although the State has no important producing district in which copper is the principal metal, yet it ranked eighth among the copper-producing States in 1910. The total recorded output for the State from the beginning of the industry has been 203,752,063 pounds, or 1.33 per cent of the total output for the United States since 1845. It is probable that the actual output is somewhat in excess of this figure, as some of the copper assigned in the earlier Survey reports to "lead desilverizers" should doubtless be credited to Colorado.

The main production has been derived from the treatment of mixed ores in which copper was of minor importance, including lead-silver ores and pyritic ores rich in gold and silver. The largest production in 1910, as in previous years, was from Lake County and from San Juan, Hinsdale, Ouray, San Miguel, Clear Creek, and Gilpin counties. Leadville and the San Juan-Ouray districts have been the greatest producers of copper.

Most of the output is recovered as matte in lead furnaces, though two copper smelters, the Boston & Colorado, at Denver, and the plant of the Modern Smelting & Refining Co., at Utah Junction, were operated for a portion of the year.

The year witnessed the dismantling of the plant of the Boston & Colorado Smelting Co. and the passing of this pioneer in the copper-smelting industry of the West. Although this company has been successful in its long period of operations, the management did not consider it wise to rebuild the plant, which was becoming out of date. This pioneer plant has had a long and successful career, but copper smelting plants constructed in the State in recent years have been far less successful and have been able to operate but intermittently.

IDAHO.

During 1910 Idaho produced 6,877,515 pounds of blister copper, as compared with 7,096,132 pounds in 1909. The State has made a small and irregular output of copper since 1884, but only since 1903 has it been a steady and important producer. To the close of 1910 it had a recorded output of 54,557,684 pounds.

The Cœur d'Alene district furnished most of the copper output for 1910 and has been the most productive copper district in the State. Complete figures for the copper output of the district are not on record but the total production has been approximately 43,000,000 pounds.

The Snowstorm mine is the most important copper producer of the district. This deposit [1] consists of disseminated bornite, chalcocite, and chalcopyrite in certain beds of a pre-Cambrian quartzite; in the upper portion the deposit is oxidized. The lode varies from a few feet to 40 feet in width, and has been developed to a depth of 1,200 feet below the outcrop. Development is by tunnels. The ore, being highly siliceous, is well adapted for converter linings and consequently receives favorable smelting rates. The shipping ore yields

[1] Ransome, F. L., and Calkins, F. C., The geology and ore deposits of the Coeur d'Alene district, Idaho: Prof. Paper U. S. Geol. Survey No. 62, 1908, pp. 150–152.

3.5 to 4 per cent copper with about 6.5 ounces of silver and a little gold per ton.

The Elder district in Custer County made a considerable production in 1910, and the State contains other promising copper deposits, but owing to lack of development or poor transportation facilities, they have not been active since the decrease in the price of copper in 1907.

MICHIGAN.

The production of copper in Michigan in 1910 was 221,462,984 pounds, as compared with 227,005,923 pounds in 1909. The decrease in output was due entirely to voluntary curtailment resulting from the general condition of the market. The mines were capable of making a record production.

The mining of copper in Michigan antedates the earliest visits of European explorers to the region. The production on a commercial basis, however, dates from 1845, since which time the district has been a steady producer and an important factor in the copper industry of the world. To the close of 1910 Michigan has produced 4,756,420,142 pounds of copper, or 31.1 per cent of the output from the United States since 1845. For many years subsequent to 1845 Michigan was the most important copper-producing State and in total output is second only to Montana. The entire output is from the Keweenaw or Lake Superior district.

In the value of metal output, in the profits resulting from this output, in the development of mining and metallurgical processes, and in the general high standing of the companies conducting the operations, the district takes high rank among the great mining camps of the world. Previous to the perfection of the electrolytic process of refining, "Lake" copper enjoyed the distinction of being the highest grade produced, and even to the present time it sells at a figure slightly higher than the copper from other districts.

Although the district has been an active producer for 65 years, most of the older mines still have large reserves of ore and new mines are being opened, while much territory remains to be prospected. Moreover, it is claimed that a large tonnage of the mill tailings produced when milling methods were less efficient than at present can be re-treated at a profit.

Perhaps the most important developments of the last few years are those in the southern part of the district where the Lake mine and neighboring properties have disclosed what may prove to be large bodies of ore in a section of the district that hitherto has been less promising than the more fully developed area to the north, the deposits of this section are, however, characteristically "bunchy" and further development will be necessary to prove their value. Although the exhaustion of some of the older mines is in sight, yet it seems probable that the district has as long a life before it as any producing district in the United States.

The Lake Superior region is unique in being the only district from which a large output is derived from native copper. The rocks [1] of the district comprise a thick series of rather basic lava flows and

[1] For detailed description of the Keweenaw series see Irving, R. D., Mon. U. S. Geol. Survey, vol. 5; Geol. Survey Michigan, vols. 5 and 6; Rickard, Eng. and Min. Jour., vol. 88; Pumpelly, Raphael, Geol. Survey Michigan, vol. 1, 1873; Lane, A. C., and Hubbard, L. L., Geol. Survey Michigan, vol. 4, 1898; Reminger, C., Geol. Survey Michigan, vol. 5, 1905.

intercalated beds of conglomerate and sandstone of pre-Cambrian age. These have been tilted so that they have a northwest dip, usually rather steep, and strike in a general northeast-southwest direction. The copper occurs in the cellular portion of the lava flows, which form the amygdaloid lodes, and as a cement and to some extent a replacement of the conglomerate pebbles forming the conglomerate lodes. Copper also occurs in fissures crossing the formations, but at present these are of little commercial importance, though in the early days of the district considerable copper was derived from this type of deposit. A little native silver occurs with the copper. The lodes are of low grade, but characterized by great extent and rather uniform distribution of the metallic content. This, together with the fact that the ore is susceptible of high concentration with low cost of refining the resultant "mineral," makes it possible to work these low-grade deposits at a good profit. The native copper occurs in the lodes in masses varying from microscopic size to bodies weighing hundreds of tons. The richest lode mined at present carries but 1.5 per cent copper, and the poorest rock treated yields but little above five-tenths of 1 per cent of metal. For this low-grade ore to be profitable it must be handled on a large scale; this has resulted in the construction of the immense plants that characterize the Lake district. The lodes are worked for the most part through inclined shafts, though some of the deeper deposits are opened by vertical shafts. The workings have been extended in some cases to a mile in vertical depth, or about a mile and a half down the lode. Pillars of rock are left to keep the lodes open, and dry walls constructed from the waste sorted underground serve the same purpose in some of the mines. Much timber, however, is required in some of the mines, especially those operating on the conglomerate lodes.

The rock coming from the mines is crushed by steam stamps and concentrated, producing "mineral" containing an average of about 62 per cent copper. This is subjected to a combined smelting and refining process. A small amount of "mass" and "barrel work" copper are sorted out at the mine and go direct to the smelter. A portion of the output is refined electrolytically; this consists of copper sufficiently argentiferous to make the recovery of silver profitable, and of copper containing so high a percentage of impurities that further refining is necessary for certain uses. During 1910 slightly over 15 per cent of the output was refined electrolytically.

Silver in important amount is recovered only from the copper treated electrolytically. The average recovery per ton of rock from which the copper was refined electrolytically was approximately 0.2176 fine ounce.

In the following table is given the production of individual companies compiled from their annual reports, together with the cost of production and the price received for the copper. The average cost of production for the district was approximately 9.857 cents per pound, and the average price received was 12.993 cents per pound, or an average profit of 3.136 cents per pound.

Approximately 20,000,000 pounds of copper, about 9 per cent of the total, was produced at a loss, more than one-half of this being produced by the Tamarack Mining Co. and a considerable part of the remainder by companies that are still in the development stage.

Production of copper by Michigan mines for 1909 and 1910, in pounds, compiled from the annual reports of the producing companies.[a]

Company.	1909	1910	Cost per pound, 1910.	Price received per pound.	Profit (+) or loss (−).
	Pounds.	*Pounds.*	*Cents.*	*Cents.*	*Cents per pound.*
Ahmeek	9,198,110	11,844,954	11.05	12.94	+1.89
Allouez	4,031,532	4,655,702	11.57	12.67	+1.10
Baltic	17,817,836	17,549,762	8.32	12.74	+4.42
Calumet and Hecla	80,096,995	72,059,545	8.96	13.20	+4.24
Centennial	2,583,793	1,572,566	14.48	12.83	−1.65
Champion	18,005,071	19,224,124	7.85	12.74	+4.89
Franklin	1,615,556	966,353	14.63	13.07	−1.56
Gratiot		265,869			
Isle Royale	5,719,056	7,567,399	11.84	12.65	+ .81
La Salle		472,100			
Mass	1,723,436	1,321,885			
Michigan	1,979,305				
Mohawk	11,248,474	11,412,066	11.44	13.09	+1.65
Osceola	25,296,657	19,346,566	9.37	13.00	+3.63
Quincy	22,511,984	22,517,014	10.48	13.21	+2.73
Superior	1,781,315	3,181,041	14.29	12.63	−1.66
Tamarack	13,533,207	11,063,606	14.70	12.97	−1.73
Trimountain	5,282,404	5,694,868	12.17	12.74	+ .54
Victoria	1,062,218	1,164,564			
Wolverine	9,757,101	9,617,168	7.542	12.58	+5.04
Average			9.857	12.993	+3.136

[a] Since this table includes mines reporting their output both for the calendar and for the fiscal years, and since some of the companies report the refined copper equivalent of mineral produced and others report refined copper, the amounts do not necessarily agree with the total of either mine or the smelter output.

The average copper yield per ton of rock milled during 1910 was 20.5 pounds, the same as for 1909. The average copper recovery from conglomerate rock for 1910 was 28.3 pounds per ton and for amygdaloid 18.2 pounds per ton. The copper derived from the two types, respectively, was 31.4 and 68.6 per cent.

During 1910 the rock milled amounted to 10,869,561 tons, as compared with 11,429,394 tons for 1909.

The change in grade of ore handled by the Lake companies is shown in the following table. The figures are compiled from the annual reports of the companies.

Tonnage and yield of ore milled by Michigan copper companies in 1909 and 1910, compiled from the annual reports of the producing companies.[a]

Company.	1909		1910	
	Tonnage.	Yield per ton.	Tonnage.	Yield per ton.
Ahmeek	406,045	22.07	530,365	22.33
Allouez	253,049	15.93	247,119	18.84
Baltic	814,260	21.88	781,419	22.46
Calumet and Hecla	2,842,880	28.18	2,795,514	25.77
Centennial	196,525	13.15	102,133	15.40
Champion	753,908	23.88	722,051	26.62
Franklin	170,546	9.47	113,859	8.49
Gratiot			28,522	9.32
Isle Royale	401,280	14.30	520,860	14.53
La Salle			35,520	13.29
Mass	139,404	12.36	90,747	14.59
Michigan	146,971	13.47		
Mohawk	819,019	13.73	802,537	14.22
Osceola	1,494,845	16.90	1,217,720	15.90
Superior	81,641	21.82	140,514	22.64
Tamarack	689,099	19.60	525,554	21.10
Trimountain	323,408	16.33	317,299	17.95
Victoria			122,497	9.51
Wolverine [b]	390,837	24.96	388,476	24.75

[a] This table includes only mines reporting their tonnage and yield for the calendar year.
[b] Figures are for fiscal year ending June 30, 1911.

The district is well located for cheap working of the mines. The Great Lakes furnish cheap transportation for both coal and copper, the Lake transportation being brought into the heart of the district by Portage Lake and the Houghton ship canal. The district is served by the Mineral Range, Copper Range, and Keweenaw Central Railroads and is connected with the main lines of traffic by the Chicago, Milwaukee & St. Paul and the South Shore & Atlantic Railroads.

Toward the close of the year steps were taken to effect a consolidation of the Calumet and Hecla interests with a view to more economical and efficient development and working of the properties than has been possible with the individual units. It is proposed to consolidate the following properties: Calumet and Hecla, Seneca, Ahmeek, Allouez, Osceola, Centennial, Tamarack, Laurium, La Salle, and Superior.

MONTANA.

The output of blister copper from Montana in 1910 was 283,078,473 pounds, as compared with 314,858,291 pounds in 1909. The State thus again ranks second to Arizona in copper production.

The first record of production of copper from Montana is for 1868, but the State did not become an important contributor of this metal until 1880. Since that time there has been a steady and rapid increase in the copper output. To the close of 1910 the State has yielded 5,326,439,393 pounds, or 34.83 per cent of the total output of the United States since 1845. In total production the State ranks first and in the output for 1910 it ranked second. The Butte district has furnished nearly the entire output of the State.

Four copper-smelting plants were operated in the State in 1910: The plant of the Colusa-Parrot Mining & Smelting Co., at Butte; the smelter of the East Butte Mining Co., at the same place; the smelter of the Washoe Copper Co., at Anaconda; and the smelter of the Boston & Montana Copper Co., at Great Falls.

Butte district.—In 1910 the Butte district, Silver Bow County, produced about 282,500,000 pounds of copper, or about 26 per cent of the total output of the country.

The presence of copper minerals in the district has been known since the discovery of gold in 1864, and attempts were made to treat the ores as early as 1866; but it was not until the late seventies that the district began to attract attention as a copper camp, and large production did not begin until a railroad reached the district in 1881. To the close of 1910 the Butte district has produced about 5,315,000,000 pounds of copper, or 34.75 per cent of the total output of the country since 1845. In total production and in the output for 1910 it ranks first among the copper-producing districts of the United States.

The copper ores [1] of the district occur as replacement veins in a granitic rock known technically as quartz monzonite. These veins form complex systems of slightly different ages.

The principal original ore minerals in the copper veins are pyrite, chalcopyrite, enargite, bornite, chalcocite [2], with varying amounts of sphalerite. It has been generally considered that the commercial ore

[1] Weed, W. H., Bull. U. S. Geol. Survey No. 285, 1905, p. 112. Weed, W. H., Geology and ore deposits of the Butte district, Montana: Prof. Paper U. S. Geol. Survey No. 74 (in press).
[2] Sales, Reno H.: Econ. Geology, vol. 5, 1910, p. 681.

has resulted from the process of secondary enrichment and that the original mineralization was too low in copper content to be of commercial importance; but more recently the geologists of the district have considered that all the ore minerals in the deeper levels are of primary origin—that is, that they were deposited from ascending solutions, and that only the upper part of the deposit has been effected by secondary enrichment resulting from descending solutions. This conclusion, however, does not appear as yet to have been generally accepted and a more detailed description and discussion of the facts on which it is based than has yet been published is highly desirable. The ores may be divided into two general classes as regards treatment: The sulphide-quartz smelting ores, and the concentrating ores consisting of altered quartz monzonite impregnated with grains of sulphide. In the early days of mining in the district chalcocite was by far the most important copper mineral. With increase in depth of the workings, however, the amount of copper derived from enargite has increased until it probably nearly equals the amount derived from chalcocite.

The grade of ore mined in the district is regulated to a considerable degree by the possibility of profitable treatment. An increase in the price of copper or a decrease in the cost of mining and treatment permits the mining of lower grade ores. In 1910 the average yield was 3.13 per cent copper, as compared with 3.08 per cent in 1909 and with 3.3 per cent in 1908. In 1910 smelting ores averaging 5.68 per cent copper furnished about 22 per cent of the output derived from ores, and concentrating ores averaging 2.78 per cent furnished about 78 per cent. The ores averaged 2.02 ounces silver and 0.0068 ounce gold per ton, the precious metal content reducing the cost of copper nearly 2 cents per pound.

Early in the year steps were taken to combine the Amalgamated interests in the district under one company with a view to decreasing the cost of production by working them as one property and to eliminate the vexing question of the ownership of ore bodies. The stock of the Anaconda Copper Co. was accordingly increased and exchange was made for the stock of the Boston & Montana Copper & Silver Mining Co., Red Metals Mining Co., Washoe Copper Co., Butte & Boston Consolidated Mining Co., Big Blackfoot Mining Co., Trenton Mining & Development Co., Parrot Silver & Copper Co., Alice Gold & Silver Mining Co., and the Diamond Coal & Coke Co. The copper properties of W. A. Clark, including the Butte Reduction Works, which were closed down, were also purchased. The ore from these properties went to the other smelters of the company for treatment.

During the year the use of electric power was being extended. Hoisting by means of compressed air produced by electric power was put in operation at the High Mountain View Ore mine in 1911, and further extension of electric power for pumping, hoisting, and underground haulage is planned.

The reduction works at Anaconda and Great Falls treated a total of 4,337,688 tons of ore and other cupriferous material, yielding 266,608,461 pounds of copper, 9,534,888 ounces of silver, and 57,259 ounces of gold.

The greatest amount of development by the North Butte Mining Co. was on the Jessie vein, where the management reports opening

a large body of ore on the 2,000-foot level and a good amount of ore on the 2,200-foot level. In sinking the Speculator shaft high-grade bornite and chalcocite were encountered at a depth of 2,740 feet. During the year the company produced 408,528 tons of ore, and at the end of the year ore in sight was reported as 958,680 tons of an average assay value of 4.25 per cent copper and 3 ounces of silver per ton. The total average cost per pound of copper for the year was 10.356 cents.

The East Butte Copper Mining Co. operated the Pittsmont smelter and its mines during the year. The management reports the development of an important ore body on the vein known as No. 824. During the fiscal year ending March 31, 1911, the company produced 85,876 tons of ore assaying 5.51 per cent copper, and the smelter shipped 11,417,904 pounds of copper, 432,218 ounces of silver, and 13,119 ounces of gold.

The district is served by three trunk lines of railroad, and a private standard-gage line connects the mines with the Washoe smelter at Anaconda. Much of the timber used in the district comes from the extensive timber lands controlled by the Amalgamated Co. Coal is also largely derived from the mines owned by this company in Montana and Wyoming. For power purposes electric power derived from Missouri River and other streams is largely replacing steam power.

NEVADA.

The production of blister copper in Nevada in 1910 was 64,494,640 pounds, as compared with 53,849,281 pounds in 1909, the increase being from the Ely district.

The earliest record of the production of copper in Nevada was for 1873, but it did not become an important factor in the copper industry until 1908, when production from the Ely district began.

To the close of 1910 the State has a recorded production of 137,939,097 pounds, or 0.9 per cent of the output of the country since 1845. To this should probably be added a small but unknown quantity produced as bluestone in the early days of mining in the State and used locally in the treatment of gold ores. In total production Nevada ranks eighth and in the output for 1910 fifth among the copper-producing States.

Ely district.—The Ely district, White Pine County, was the only important producing district in the State in 1910. Although it has long been known that the district contained copper deposits, active development on an important scale began but a few years ago and important production did not begin until 1908, when the Steptoe Valley smelter and concentrating plant was completed.

During 1910 the district produced about 63,800,000 pounds of blister copper, and to the close of 1910 the output has been about 125,000,000 pounds. The district has yielded 0.81 per cent of the total output of the country since 1845 and 5.9 per cent of the production of 1910. In total production it ranks tenth and in the production for 1910, sixth among the copper districts of the country.

The district is in the Egan Range, the geology [1] of which may be summarized as follows: Paleozoic limestones and shales have been

[1] Lawson, A. C., Bull. Dept. Geology Univ. California, No. 4, p. 284. A detailed report on the district is in preparation by the United States Geological Survey.

invaded by a granitic intrusive technically known as quartz monzonite porphyry. Later the area was buried beneath lava flows which have been in large part removed by erosion.

The copper ores are of two types, replacement deposits in limestone near the porphyry contact and disseminated deposits in porphyry. The deposits in limestone thus far developed have been principally oxidized ores, and there has been but small production from this type. In the disseminated type the original ores consisted of small veinlets and grains of pyrite and chalcopyrite disseminated through the greatly shattered and highly altered porphyry. The commercial ore has resulted from the secondary enrichment of these deposits by the removal of the copper from the upper portion and redeposit as chalcocite on the sulphides lower down, the commercial ore consisting of grains of pyrite and chalcopyrite partly or entirely replaced by chalcocite. The leached capping is of varying thickness, but for a part of the deposit it is thin enough to permit of its removal and the mining of the ores by steam shovels; for the remainder underground methods will be employed.

During the year 2,346,354 tons of copper ore mined in the district produced concentrates containing 62,332,419 pounds of copper. The average recovery in concentrates per ton of ore from the district was copper 1.3 per cent, with about 21 cents in gold and silver per ton of ore. Smelting ores amounting to 28,325 tons contained 2.77 per cent copper, with 60 cents in gold and silver per ton.

The Nevada Consolidated Copper Co. and the Giroux Consolidated Mines Co. were the most active operators in the district, the production being mainly by the former company.

The production of the Nevada Consolidated Copper Co. for 1910 was almost entirely from the Copper Flat pit, though the Liberty area was partly stripped and prepared for production of ore in 1911. The ores were treated at the company's concentrating and smelting plant at McGill.

The company reported as developed during the fiscal year ending September 30, 1910, a total of 14,500,555 tons of ore, averaging 1.28 per cent copper, with a total of 40,360,828 tons developed reserve capable of extraction, averaging 1.70 per cent copper.

The following table gives the results of operations of the company during the fiscal year:

Results of Nevada Consolidated Copper Co.'s operations for fiscal year 1910.

Ore treated (dry)	short tons	2,237,028
Average copper assay	per cent	2.06
Extraction of copper	do	69.59
Ratio of concentration		10.6 to 1
Assay value in gold	ounces	.0181
Assay value in silver	do	.0879
Extraction of gold	per cent	49.78
Extraction in silver	do	48.36
Average gold and silver recovered per ton of ore	cents	21.14
Average copper in concentrates	per cent	15.21

Operations of the Giroux Co. were confined to development. Work was continued on the new shaft and connections to open the ore bodies found on the 1,000-foot and 1,200-foot levels in the old Alpha shaft, and these should be reached early in 1911. Development of disseminated deposits by churn drill was continued, and at the close of the year

the management reported as developed 9,620,000 tons of ore, averaging 1.36 per cent copper and 40 cents in gold and 20 cents in silver per ton. It is expected that the company will enter the producing class in 1911.

The district is served by the Nevada Northern Railroad, controlled by the Nevada Consolidated Copper Co., connecting with the Central Pacific Railroad at Cobre.

All the raw material for smelting operations except fuel are from the district. Siliceous ore is obtained from the "dike" of siliceous copper ore in the Copper Flat pit, and limestone for fluxing is quarried near the smelter. Coal as a fuel is being replaced by oil.

Yerington district.—At the Yerington district in Lyon County development was continued during the year, but no important production was made.

Copper ores have been mined in the district for many years. In the early days considerable natural bluestone was mined and used in the treatment of gold ores at Virginia City. Later an attempt was made to smelt the ores, but with little success. No accurate data of the total output of the district has been compiled, though it has not been large. During the last few years development of ore by several companies has been in progress and it is reported that considerable ore carrying copper values of 3 per cent or better have been opened.

The ores of the district according to Ransome [1] are of three types of occurrence:

(1) Irregular bodies formed by metasomatic replacement of limestone and genetically associated with metamorphism of a kind usually attributed to contact action of intrusive rocks; (2) metasomatic vein deposits in altered limestone; and (3) metasomatic vein deposits in granodiorite.

The most important developments are of ore bodies of the first type. The original sulphides of these are pyrite and chalcopyrite in various proportions, with a gangue of pyroxene, amphibole, epidote, garnet, and calcite.

During the year ground was broken for the construction of an 800-ton smelter near Wabuska by the Mason Valley Mines Co., but this smelter will not be completed before late in 1911.

The district is served by the Nevada Copper Belt Railway, which connects with the Goldfield branch of the Southern Pacific at Wabuska.

A small production was made from several other districts in the State, mostly from lead-copper and siliceous ores.

NEW MEXICO.

The production of blister copper in New Mexico in 1910 was 3,784,609 pounds, as compared with 5,031,136 pounds in 1909.

Production of copper from New Mexico began in the last years of the eighteenth century, native copper from the mines of Grant County being carried to Mexico City and coined into money. A little copper is reported for about the year 1860, but the Territory did not have a steady output until after 1880 and did not become an important factor in production until 1900. From 1845 to 1910 the Territory has a recorded output of 92,323,163 pounds of copper, or 0.6 per cent of the output of the country since 1845. The principal production has been from the districts in Grant County.

[1] Ransome, F. L., The Yerington district, Nevada: Bull. U. S. Geol. Survey No. 380, 1909, p. 99.

Santa Rita district.—The Santa Rita district in Grant County made a production of about 2,670,000 pounds of copper in 1910, as compared with about 3,300,000 pounds in 1909. This was probably the first district in the West from which important copper production was made, the output beginning in the closing years of the eighteenth century, and the metal going to Mexico for coinage. There are no accurate records of the production for this early period of operation, but from the best sources available it is estimated that the total production to the close of 1910 has been approximately 103,000,000 pounds.

The geology [1] of the district is rather complex. The sedimentary series, consisting of quartzite, shales, and limestone, has been invaded in post-Cretaceous time by a granitic rock technically known as quartz monzonite porphyry. After a period of erosion the area was buried beneath Tertiary volcanic flows, which in turn have been largely removed by erosion.

The copper deposits may be divided into two types, contact deposits and disseminated deposits. The contact deposits occur as replacement of limestone near the porphyry contact and have been most extensively worked in the Hanover end of the district.

In the disseminated deposits the ore minerals occur as small veins and grains of mineral in shattered quartzite and highly altered porphyry. Unlike many of the disseminated deposits, much of the copper occurs native and as the oxide, though chalcocite ores are also abundant. To the present time the main production has come from shallow workings following high-grade streak of native copper oxide and chalcocite ores. The average recovery of copper from ores mined in the district in 1910 was 3.8 per cent.

Since 1909 the Chino Copper Co. has been actively developing the main mineralized area by means of churn drills, and the management reports, March 1, 1911, developed and partially developed ore to the amount of 45,238,312 tons, with an average copper content of 2.3 per cent.

The average thickness of the ore body is 107 feet and the average thickness of the barren capping is 82 feet. It is stated that over 71 per cent of the developed ore can be extracted by steam-shovel methods, and a part of the area has already been stripped for mining.

A concentrating plant with a daily capacity of 3,000 tons, which will be ready for operation late in 1911, is in process of construction at Hurley, about 9 miles from the mines. The concentrates will be shipped to El Paso for further treatment.

The district is served by a branch of the Santa Fe Railroad connecting with the main line and with the Southern Pacific at Deming.

Burro Mountain district.—The Burro Mountain district southwest of Silver City made but a small production in 1910. The total production from the district has probably been about 10,000,000 pounds of copper.

The Burro Mountain [2] consists of a pre-Cambrian complex that has been intruded by monzonite porphyry. The copper ores occur

[1] Lindgren, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, p. 305.
A report on the geology of the Silver City quadrangle is in preparation by the United States Geological Survey.

[2] Lindgren, W., Graton, L. C., and Gordon, C. H., Ore deposits of New Mexico: Prof. Paper U. S. Geol. Survey No. 68, 1910, p. 321.

mainly as impregnations and replacements along irregular fractures and zones of crushing. The primary sulphide is cupriferous pyrite, but the workable deposits have resulted from the secondary enrichment of the primary ores.

Development by churn-drill and underground methods during the year considerably increased the ore reserves. The Burro Mountain property, controlled by Phelps, Dodge & Co., is held as an ore reserve and important production will probably not be made for some time.

The Lordsburg district was the only other important contributor to the copper output of the Territory.

TENNESSEE.

The production of blister copper from Tennessee in 1910 was 16,691,777 pounds, as compared with 19,207,747 pounds in 1909.

The decrease in production was due to the inability of the sulphuric-acid plants to handle the fumes from the smelters when operated at full capacity. The entire output was from the Ducktown district located in the extreme southeastern part of the State in Polk County. The district was one of the earliest large producers in the country. Operations began about 1850, and from that date till the close of the Civil War there was a large production from the "black-copper" ores. With the exhaustion of the rich secondary deposits attempts were made to work the lean original sulphides. These efforts met with only indifferent success, and in the late seventies the smelters shut down, thus ending the first period of activity in this district. The present period of activity began in 1890, when the Ducktown Sulphur, Copper & Iron Co. began operations. Since that time the district has been a steady producer from the primary sulphide ores. To the close of 1910 the total output of the district has been approximately 211,700,000 pounds.[1]

The ores[2] occur as steeply dipping lenses replacing calcareous bands in schist, the ore bodies in general conforming to the dip and strike of the schistosity of the inclosing rock. The principal sulphide is pyrrhotite, with subordinate pyrite, chalcopyrite, and sphalerite. Extensive gossans cap the ore bodies, and it was the enriched zones underlying these that furnished the rich chalcocite ores that were extracted during the first period of activity.

In 1910 the ores of the district yielded a little over 30.4 pounds of blister copper per ton, or 1.52 per cent, with an average of 0.66 cent gold and silver per pound of copper that was treated electrolytically. A part of the copper is marketed without electrolytic refining. The fact that the ores can be extracted without timbering, the cheap supply of coke and coal from Tennessee and West Virginia, and the comparatively low cost of labor have made it possible to mine and treat these low-grade ores at a profit.

The pyritic process of smelting is practiced successfully by both companies. The low-grade matte produced by the first smelting is resmelted and brought to a proper grade for conversion.

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[1] The production of the district has been compiled by Prof. W. H. Emmons and kindly furnished to the writer before publication.

[2] The deposits have been described by Henrich, Carl, Am. Inst. Min. Eng., vol. 25, p. 173; Weed, W. H., Am. Inst. Min. Eng., vol. 30, p. 452; Kemp, J. F., Am. Inst. Min. Eng., vol. 31, p. 224; Higgins, E., Eng. and Min. Jour., vol. 86, 1908, pp. 1237–1241; Channing, J. P., Min. and Sci. Press, vol. 96, 1908, p. 97; Gottsberger, B. B., Mining World, vol. 29, 1908, pp. 911–914; Weed, W. H., Ore deposits of the Appalachian States, Bull., U. S. Geol. Survey, No. 455, 1911, p. 152.

A detailed report on the district is in preparation by the United States Geological Survey.

Sulphuric-acid plants were operated by both the Ducktown Sulphur, Copper & Iron Co. and the Tennessee Copper Co. The successful operation of these plants has apparently not only solved the troublesome smelter-smoke problem, but added very materially to the revenue of the companies. The sulphuric-acid production will probably be fully as important in the future as the copper output.

The Tennessee Copper Co., in 1910, treated 424,197 tons of ore from the district, yielding 12,429,009 pounds fine copper, a yield of 29.3 pounds per ton, or 1.465 per cent. The ore reserves of the company's mines at the close of the year amounted to 3,183,671 tons of available ore and 1,380,000 tons of probable ore, a total of 4,563,671 tons. During the year the furnaces were remodeled to adapt them to the acid plant. The sulphuric-acid plant was completed and should be capable of operating at full capacity for 1911.

The district is served by a branch line of the Louisville & Nashville Railroad, the mines and smelters of the companies being connected with this by private lines.

UTAH.

In 1910 Utah produced 125,185,455 pounds of blister copper, as compared with 101,241,114 pounds in 1909. The marked increase was due to the production from the Bingham district.

The first record of production of copper from Utah is for 1872. The State did not become an important copper producer, however, until late in the nineties, since which time the growth of the industry has been steady and rapid. The total recorded output from the State to the close of 1910 has been 658,774,460 pounds, 4.31 per cent of the output from the United States since 1845. In 1910 Utah produced 11.59 per cent of the output. In total output and in the production for 1910 it ranks fourth among the copper-producing States.

Three copper-smelting plants were operated in the State during 1910. The matte smelter of the Yampa Smelting Co. was operated until August, when it was shut down and the ores of the company were shipped to the Garfield smelter. The Garfield smelter was operated throughout the year. The new plant of the International Smelting & Refining Co. at International was completed and placed in operation July 25, 1910, but was not operated at full capacity up to the close of 1910.

Bingham district.—The Bingham or West Mountain district, Salt Lake County, made about 112,000,000 pounds of blister copper in 1910, as compared with about 86,000,000 pounds in 1909.

The presence of copper minerals has been known since the early days of mining in the district, but for many years operations were confined to the production of lead, silver, and gold. Not until 1896 did the mining of copper ore become of commercial importance. To the close of 1910 the district has produced approximately 465,000,000 pounds, or 3.04 per cent of the output of the country since 1845. For 1910 the district yielded 10.37 per cent of the total production. In total output the district ranks sixth among those of the country and in the production for 1910 it ranks fourth.

The ore deposits of the district [1] are closely associated with masses of monzonite intruded into a series of quartzites with intercalated

[1] For detailed information see Boutwell, J. M., Economic geology of the Bingham mining district, Utah: Prof. Paper U. S. Geol. Survey No. 38, 1905.

beds of limestone and shale of Carboniferous age. The ores are of two types of occurrence—as irregular replacement deposits of limestone near the monzonite contact, and as disseminated deposits through altered porphyry.

Prior to 1907 most of the copper from the district was derived from the contact deposits in limestone. These are massive bodies of pyrite carrying chalcopyrite in varying amounts. Secondary enrichment has not been of great importance in this type of deposit. The ores vary greatly in copper content and consequently the average percentage derived for a given year depends largely on the grade that can be worked at a profit at the price of copper. In 1910 the ores yielded about 2.28 per cent copper and $2.50 in gold and silver per ton of ore. About 475,000 tons of this type of ore was produced during the year, yielding nearly 22,000,000 pounds of copper.

The primary mineralization of the disseminated type consists of grains of pyrite and chalcopyrite disseminated through the highly altered porphyry. The commercial ore is the result of secondary enrichment, the copper content near the surface being partially leached and redeposited as coatings of chalcocite and occasionally as bornite and covellite on the sulphides lower down. The commercial ore forms a blanket-like deposit covered by the leached capping and underlain by the lean primary mineralization. The average thickness of the commercial ore is stated to be 345 feet. The thickness of the capping varies greatly at different points. On the original Utah copper ground it is stated to be 80 feet, while the average for the original Boston Consolidated ground is estimated to be 160 feet. The average thickness of capping over all the ore of the Utah Copper Co. is estimated at 105 feet. The secondary enrichment in the Bingham disseminated ores is less than in several of the other disseminated deposits. The ores are extracted by both steam shovel and underground methods. During the year more than 4,700,000 tons of disseminated ore was mined, yielding about 1 per cent copper and about 21 cents in gold and silver per ton.

The ores were treated at the mills at Garfield, at the Copperton mill at Bingham until August, and at the Ohio Copper Co.'s mill. The ores and concentrates from the district were reduced at the Garfield smelter, the Yampa smelter, and the International smelter.

During the year the Utah Copper Co. increased the capacity of its Magma mill to 10,000 tons of ore per day. The Arthur mill was in process of reconstruction after the design of the Magma and when completed will have a capacity of 8,000 tons daily. The Copperton plant was closed. The mills of the company treated 4,340,245 tons of ore, with an average copper content of 1.54 per cent. The average extraction was 66.55 per cent, equivalent to 20.51 pounds of copper per ton of ore treated. The total production for the year by the Utah Copper Co. was 89,019,511 pounds. The average cost of producing this copper was 8.069 cents per pound. The company reported at the close of the year 152,130,000 tons of fully developed ore, 60,000,000 tons averaging 2 per cent copper, and 92,130,000 tons averaging 1.6 per cent copper. Partly developed ore with an average copper content of 1.4 per cent brings the total tonnage to 203,500,000 tons with an average copper content of 1.67 per cent.

Operations were conducted by the Ohio Copper Co. throughout the year, though the mill is not yet fully equipped.

The Utah Consolidated Mining Co. shipped 179,224 tons of copper ore, averaging 2.458 per cent copper and 0.0843 ounce of gold and 0.9627 ounce of silver per ton. At the close of the year there was reported as in sight in the mine 381,000 tons of ore averaging 2.44 per cent copper and 0.05 ounce of gold and 0.63 ounce of silver per ton. During the latter part of the year the ores were shipped over the new aerial tram to the International smelter.

After the close of the Yampa smelter the ores of that company were shipped to the Garfield smelter for treatment. Several other companies in the district were important producers of copper and copper-lead ores.

The district is served by a branch of the Denver & Rio Grande Railroad, and the Utah Copper Co. is constructing a railroad connecting its mines at Bingham with the mills at Garfield. Cable tramways are employed to considerable extent; the ores from the Utah Consolidated mines are delivered to the International smelter in this manner, and ores from other mines are delivered to the railroad over cable tramways.

Tintic district.—The Tintic district in Juab County made a production of 9,000,000 pounds of blister copper in 1910, as compared with about 6,000,000 pounds in 1909. The production of copper from the Tintic district is largely incidental to the production of other metals. The amount of ore in which copper is the most important metal constituent is relatively small. There has been a small output of copper from the district for many years, but no accurate statistics of the early output are available. Tower and Smith have made an estimate of the production to 1897, and by adding to this the production since that time, compiled from the best sources available, it is estimated that to the close of 1910 the district has yielded approximately 80,000,000 pounds of copper.

The occurrence of the ores [1] may be briefly summarized as follows: The sedimentary series, consisting of limestone and quartzite, has been intruded by an extensive mass of monzonite. The ores occur as replacement deposits in the limestone near the monzonite contact, as replacement veins in the igneous rocks, and as replacement veins in the sedimentary series.

The most valuable deposits developed are of the last-named type. The fissures are usually nearly vertical, and the replacement bodies are extremely irregular in form and variable in size. The original minerals were pyrite, galena, sphalerite, and enargite, with rich silver and gold minerals in a gangue of quartz and barite.

There has been little development below the water level, which is usually below 1,600 feet in the deposits in limestone, and oxidation to this point has been very complete. Recent developments below the water level in some of the mines have been encouraging, revealing sulphide ores of high grade.

The Centennial-Eureka mine was the most important producer of copper in 1910 as in previous years.

Frisco district.—The Frisco district of Beaver County made a production of about 1,100,000 pounds of copper in 1910, as compared with about 1,200,000 pounds in 1909.

[1] For detailed report, see Tower and Smith, Nineteenth Ann. Rept. U. S. Geol. Survey, pt. 3, 1899, pp. 601-767.

The first important production of copper from the district was from the Horn Silver mine in 1889, and since that time there has been a production of copper from lead-silver ores and from small copper mines. The importance of the district as a copper camp dates from the starting of the mill in 1905 to treat the ores of the Cactus mine. To the close of 1910 the district has yielded approximately 29,000,000 pounds of copper.

At the present time the Cactus mine of the South Utah Mines and Smelters Co. is the only important producer of copper ores.

The ores,[1] which consist of pyrite and chalcopyrite, occur disseminated in a highly brecciated and altered area of quartz monzonite. Most of the ore is low grade and requires concentration before shipping. The mill was shut down early in 1909 and operations were not resumed until October, 1910. During the interval the mill was remodeled and is said to be capable of handling in excess of 1,000 tons daily.

Lucin district.—During the last few years this district has been a considerable producer of copper.

The ores are reported to occur as replacement of limestone associated with an intrusive rock.

In addition to the districts mentioned, several lead-silver camps contributed to the copper output of the State.

OTHER STATES.

New Hampshire.—New Hampshire made a production of 12,409 pounds of blister copper in 1910, as compared with 88,744 pounds in 1909. The output was from the Milan mine, Coos County. The ores,[2] which consist mainly of pyrite, chalcopyrite, and zinc blende with minor amounts of other sulphides, occur as lenses in schist. Much of the ore is treated for acid manufacture, and the copper is recovered from the resulting "cinders."

North Carolina.—North Carolina produced 181,263 pounds of blister copper in 1910, as compared with 120,451 pounds in 1909. The output was principally from the Virgilina district in Granville and Person counties. The deposits[3] occur as fissure veins in schist that has been invaded by granitic intrusives, and the ore veins are thought to be closely related to this intrusive. The ore minerals are bornite and chalcocite in a gangue of quartz with subordinate carbonate and epidote. The chalcocite of this deposit is thought to be in part a primary mineral.

The Gold Hill district has in recent years produced some copper, though there was little activity in the district in 1910. The deposits[4] consist of rather narrow stringers or veins of auriferous pyrite and chalcopyrite in a quartz gangue in schist.

In the latter part of 1909 some ores were produced from the Cullowhee mine, Jackson County. The output is included in the 1910 production of blister copper.

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[1] Emmons, S. F., The Cactus copper mine, Utah: Bull. U. S. Geol. Survey No. 260, 1905, p. 242.

[2] Emmons, W. H., Some ore deposits of Maine and the Milan mine, New Hampshire: Bull. U. S. Geol. Survey No. 432, 1910, p. 54.
Weed, W. H., Copper deposits of the Appalachian States: Bull. U. S. Geol. Survey No. 455, 1911, p. 18.

[3] Laney, F. B., The relation of bornite and chalcocite in the copper ores of the Virgilina district of North Carolina and Virginia: Proc. U. S. Nat. Mus., vol. 40, pp. 513–524.
Weed, W. H., op. cit., p. 67.

[4] Laney, F. B., The Gold Hill mining district: Bull. North Carolina Geol. and Econ. Survey No. 21, 1910, p. 83.
Weed, W. H., op. cit., p. 140.

The deposits [1] occur as poorly defined veins in schist. The principal ore minerals are pyrrhotite and chalcopyrite.

Oregon.—Oregon produced 22,022 pounds of blister copper in 1910, as compared with 245,403 pounds in 1909. To the close of 1910 the State has a recorded output of 2,449,784 pounds of copper. The largest production in recent years has been from the Waldo district in Grant County. The smelting plant at Takilma was idle in 1910, which accounts for the decrease in production for the State.

Pennsylvania.—The blister copper production from Pennsylvania in 1910 was 740,626 pounds, as compared with 994,089 pounds in 1909. The output was from the iron mines of Lebanon County. These ores [2] carry a small amount of pyrite and chalcopyrite, which is separated by magnetic dressing of the iron ores. The sulphides are treated for their copper values.

South Dakota.—The smelter of the Continental Copper Mining & Smelting Co., of Hill City, was idle during 1910, and the State had practically no production of copper.

Vermont.—Vermont made a production of 1,935 pounds of blister copper in 1910. The most important deposits of the State are those near Ely. These deposits have been worked at intervals since 1821 and have made a considerable contribution to the copper output of the country, though the production in the early years is not known.

The ores [3] consist of irregular lenses of pyrite, pyrrhotite, and chalcopyrite in schistose rocks that have resulted from the metamorphism of sediments.

Virginia.—Virginia produced 105,313 pounds of blister copper in 1910, as compared with 231,971 pounds in 1909.

The principal production from Virginia was from the Virgilina district and from the Dumfries district, Prince William County. The occurrence of the ores in the Virgilina district has already been mentioned under North Carolina. At Dumfries the main output is from pyritic ores carrying low values in copper. These ores are treated for the production of sulphuric acid and the resultant "cinder" is smelted for its copper content. Some copper ore is sorted in the mining of the pyrite ore. The smelter at Dumfries was not operated in 1910.

The ores consist of lenses of pyrite with a little chalcopyrite in schist.

Other districts have been productive but were not operated in 1910. The most important of these is the "great gossan lead" extending from Carroll County into North Carolina from which an important production was made from the enriched "black copper" zone underlying the gossan.

The ores [4] consist of pyrrhotite with some pyrite in schist.

Washington.—Washington made a production of 65,021 pounds of blister copper in 1910, as compared with 120,611 pounds in 1909. The State contains no important producing district, the total recorded output to the close of 1910 being but 1,977,781 pounds.

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[1] Weed, W. H., op. cit., p. 138.
[2] Spencer, A. C. Magnetite deposits of Cornwall type, Pennsylvania: Bull, U. S. Geol. Survey No. 315, 1907, pp. 185–189.
Weed, W. H., op. cit., p. 62.
[3] Smyth, H. L., and Smith, P. S., The copper deposits of Orange County, Vt.: Eng. and Min. Jour., vol. 77, 1904, p. 177.
Weed, W. H., op. cit., p. 24.
[4] Weed, W. H., op. cit., p. 116.

The Northport smelter was not operated during the year. The Tacoma smelter was operated principally on ores from outside the State.

Wyoming.—Wyoming made a production of 217,127 pounds of blister copper in 1910, as compared with 433,672 pounds in 1909.

To the close of 1910 the State has a recorded output of 25,843,400 pounds.

The Encampment district, the most important producer, was not active in 1910, as the principal company, the United Smelters, Railway & Copper Co., successors to the Penn-Wyoming Copper Co., was in litigation.

Exact statistics of the output of this district are not available, but it has probably been in excess of 20,000,000 pounds.

The most important deposits of the Encampment district [1] occur in a zone of brecciated quartzite underlying schist. The original ore was chalcopyrite with possibly some pyrite. Secondary enrichment has produced important bodies of chalcocite in the upper workings, but these give place to chalcopyrite at depth.

REFINERY PRODUCTION.

The refinery output of the United States was made by 12 plants, 8 of which employ the electrolytic method and 5 employ the furnace process on Lake Superior copper, the Buffalo plant employing both the electrolytic and the furnace refining method. Six of the large electrolytic refineries are located on the Atlantic tidewater, 5 Lake refineries are on the Great Lakes, 4 in Michigan and 1 in New York; the only plant west of the Great Lakes is at Great Falls, Mont. In addition to these refineries, there are numerous plants in different parts of the country that make a considerable output from old copper, brass, and other alloys of copper.

The output of the regular refining plants is in the form of casting, Lake, and electrolytic copper.

CASTING COPPER.

Blister copper that is low in precious metals and sufficiently free from impurities for certain uses is refined by the furnace process and ordinarily cast into ingots. This copper is usually unfit for the uses requiring a high-grade copper, such as electric transmission, brass manufacture, and rolling, but is suitable for copper castings, and a large part of it is put to that use. Lake copper excepted, a comparatively small percentage of the copper output carries such low values in precious metals that, together with the value added to the copper by electrolytic refining, these values will not more than pay for the electrolytic refining of the copper; consequently the output of casting copper is comparatively small. Some blister copper low in precious metals is exported without further treatment and is probably consumed without electrolytic refining. In the following table this is included with casting copper. A large percentage of the casting copper, shown in the table, is from the Morenci-Metcalf district, Arizona, and from the Ducktown district, Tennessee. Both districts produce a

[1] Spencer, A. C., Copper deposits of the Encampment district, Wyoming: Prof. Paper U. S. Geol. Survey No. 25, 1904.

rather high grade of blister carrying low values in precious metals, and it is found profitable to market much of it without electrolytic refining. During 1910 the production of new casting copper amounted to 72,271,426 pounds, 68,260,688 pounds being of domestic origin and 4,010,738 pounds of foreign origin.

LAKE COPPER.

By Lake copper as used in this report is meant the output of the Lake smelters. Considerable of this output is refined electrolytically, but most of the electrolytically refined Lake copper is mixed with furnace-refined copper or sold as some brand of Lake copper. Of the 221,462,984 pounds of copper produced by the Lake smelters, about 35,600,000 pounds were refined electrolyticlly, either to free it from impurities or to recover the silver content.

ELECTROLYTIC COPPER.

Under electrolytic copper, as shown in the following table, is included all new copper that was refined electrolytically, except that from the Lake district. In 1910 the production of electrolytic copper from primary materials of domestic origin amounted to 782,171,204 pounds, and that of foreign origin to 346,133,521 pounds. Electrolytic copper to the amount of 9,952,358 pounds was produced from secondary sources, making a total electrolytic production of 1,138,257,083 pounds for the year.

SECONDARY COPPER.

Under secondary copper is considered material recovered from remelting old copper, copper scraps, etc., and copper recovered from the treatment of copper alloys or alloys that are treated without the separation of the copper. One hundred and forty-nine plants reported to the United States Geological Survey as making a production from secondary sources. Though a systematic canvass of secondary plants was made for 1910, it is probable that the amount of secondary copper recovered slightly exceeds that reported.

For 1910 there was reported as recovered from the remelting of old copper, copper clippings, etc., 89,000,000 pounds; recovered from alloys other than brass, 13,000,000 pounds; and from the remelting of old brass and brass clippings, assuming this to contain an average of 70 per cent copper, there was recovered 87,000,000 pounds. The total recovery of copper reported from secondary sources is, therefore, about 189,000,000 pounds. Of this amount, about 31,000,000 pounds was recovered by the regular refining companies, and the remainder, about 158,000,000 pounds, was recovered by plants treating only secondary material. Of this production, as nearly as can be ascertained, at least 60,000,000 pounds was recovered from clean scrap produced in the manufacture of copper and brass articles, leaving approximately 129,000,000 pounds recovered from material that had entered the trade in manufactured form.

As contrasted with lead and zinc, the uses for which copper is principally employed are such that a large percentage of the metal can be eventually recovered and returned to the trade. The period

elapsing between the time when copper enters the trade and is returned as scrap varies, of course, greatly with the uses for which it is employed, and no data are available that will give even an approximation of this period. However long this period may be, it is evident that there will be an increase in the production of copper from secondary sources proportionate to the great increase in the consumption of copper. The production from old scrap in 1910 was equal to between 17 and 18 per cent of the domestic consumption of new copper, as compared with between 12 and 13 per cent for 1909. A part of this gain may be attributed to the more complete statistics for 1910, but it is also evident that there has been an actual increase. This factor of the copper industry is one that must command increasing attention in the future.

TOTAL REFINED COPPER.

The total production of new refined copper in 1910 was 1,422,039,133 pounds. This was the largest output in the history of the industry, exceeding that of 1909 by 31,017,679 pounds.

The production of electrolytic, Lake, and casting copper from primary sources and the production of secondary copper by the regular refining plants in 1909 and 1910 is shown in the following table:

Production of primary and secondary copper by the regular refining plants in 1909 and 1910.

	1909		1910	
	Domestic.	Foreign.	Domestic.	Foreign.
Electrolytic	778,808,910	323,085,954	782,171,204	346,133,521
Lake	227,005,923	.....	221,462,984	.....
Casting	59,750,088	2,370,579	68,260,688	4,010,738
	1,065,564,921	325,456,533	1,071,894,876	350,144,259
Total primary	1,391,021,454		1,422,039,135	
Secondary	14,598,065		31,040,874	
Total output	1,405,619,519		1,453,080,009	

The figures for Lake copper include the Michigan copper that was treated electrolytically, and casting copper includes blister copper that was marketed without refining.

In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively produced a total of 158,000,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 189,000,000 pounds from secondary sources. Of this total, approximately 60,000,000 pounds was produecd by remelting clean scrap produced in the process of manufacture of copper and brass articles.

If the output of plants treating purely secondary material is added to the production of the regular refining companies, the contribution of the United States to the world's supply of copper for 1910 is found to be 1,611,000,000 pounds.

During 1910 reports were made by the Copper Producers' Association of the monthly output of marketable copper by the regular

refining plants in the United States. The following table shows the the output by months and the total for the year:

Monthly output of marketable copper in 1910, as reported by the Copper Producers' Association, in pounds.

Month.	Output.	Month.	Output.
January	116,547,287	August	127,808,618
February	112,712,493	September	119,519,983
March	120,067,467	October	126,469,284
April	117,477,639	November	119,353,463
May	123,242,476	December	123,339,219
June	127,219,188		
July	118,370,003	Total	1,452,122,120

COPPER SULPHATE.

The production of copper sulphate or bluestone by the refineries of the United States in 1910 was 29,728,143 pounds, having a copper content of about 7,521,000 pounds, as compared with about 30,980,729 pounds, having a copper content of about 7,838,123 pounds, in 1909.

STOCKS.

Returns from all smelting and refining companies show that the following stocks of electrolytic, Lake, and casting copper were on hand at the beginning and the end of the year 1910:

Stocks of refined copper, in pounds.

January 1, 1910	141,486,244
January 1, 1911	122,803,656
Decrease during 1910	18,682,588

In addition to the stocks of refined copper, there were at smelters, in transit to the refineries, and at the refineries, blister copper and material in process of refining to the amount of 245,218,530 pounds January 1, 1911, as compared with 266,754,808 pounds January 1, 1910.

During 1910 the Copper Producers' Association reported the stock of the marketable copper held at all points in the United States on the first of each month. The following table shows the stocks held at the close of each month:

Stocks of marketable copper of all kinds on hand at all points in the United States on the first day of each month for 1910 and on Jan. 1, 1911, as reported by the Copper Producers' Association, in pounds.

Month.	Quantity.	Month.	Quantity.
January	141,766,111	August	170,640,678
February	98,463,339	September	168,881,245
March	107,187,992	October	148,793,714
April	123,824,874	November	139,261,914
May	141,984,159	December	130,389,069
June	160,425,973	January 1, 1911	122,030,195
July	168,386,017		

IMPORTS AND EXPORTS.

IMPORTS.

The quantity of copper in unmanufactured form imported into the United States in 1910 was 344,435,771 pounds, according to the records of the Bureau of Statistics of the Department of Commerce and Labor. The imports in 1909 were 321,801,114 pounds. The following table shows the character and source of copper-bearing materials imported during 1909 and 1910:

Imports of copper into the United States in 1909 and 1910, by countries, in pounds.

Countries.	Ore, matte, and regulus.		Pigs, bars, ingots, plates old, etc.	
	1909	1910	1909	1910
United Kingdom			26,527,574	18,649,727
Germany	6,362,283	961,534		
Spain	5,151,910	4,927,830	17,089,614	25,411,393
Canada	9,689,829	10,034,806	29,196,351	29,016,785
Mexico	23,914,040	22,731,184	76,119,724	84,006,907
Chile	18,580,601	19,425,233	5,330,633	4,239,079
Cuba	9,836,258	8,858,373		
Peru			32,344,009	40,759,887
Japan			23,830,140	18,482,989
Australia and Tasmania			17,378,819	22,913,387
Other countries	7,552,472	18,286,015	12,896,857	15,728,642
Total	81,087,393	85,224,975	240,713,721	259,210,796
Grand total			321,801,114	344,435,771

In 1910 ore to the amount of 420,220 tons, with a copper content of 64,203,789 pounds, and 33,527 tons of matte and regulus, with a copper content of 21,021,186 pounds, were imported. Of the copper imported as matte and blister about 9,700,000 pounds were derived from copper ores or matte that had been exported and treated in foreign smelters, leaving about 334,700,000 pounds derived from foreign materials. According to the report of the smelters and refiners, 350,144,259 pounds of new copper was produced in this country from foreign material, a difference of 15,444,254 pounds between the amount reported by the smelters and refiners as treated and that reported by the Bureau of Statistics as imported.

EXPORTS.

The exports of metallic copper from the United States in 1910 amounted to 708,316,543 pounds, according to the Bureau of Statistics. This is the largest export made in any year, exceeding that of 1909 (682,846,726 pounds) by 25,469,817 pounds. In addition to the exports of metallic copper, the copper content of 43,784 long tons of ore, matte, and regulus was exported in 1910, as compared with the content of 59,880 long tons in 1909.

Exports of domestic copper from the United States in 1909 and 1910, by countries.

Countries.	Ingots, bars, plates, and old (pounds).	
	1909	1910
United Kingdom	156,511,113	98,030,213
Belgium	6,016,861	7,176,258
France	99,003,962	116,193,850
Germany	138,213,200	175,961,028
Italy	26,386,069	34,110,237
Netherlands	204,378,211	221,764,806
Russia in Europe	3,519,216	6,848,311
Other Europe	41,661,979	42,203,861
Canada	6,790,410	5,628,487
Other countries	365,615	499,492
Total	682,846,726	708,316,543

The report of the Copper Producers' Association, which is based on a slightly different period, shows a delivery of 722,431,494 pounds for export.

CONSUMPTION.

The apparent consumption of refined new copper in the United States in 1910 was about 732,400,000 pounds; in 1909 it was about 688,500,000 pounds.

The method employed in determining the quantity of copper retained for domestic consumption is shown in the following table. It does not take into consideration stocks of copper held by consumers.

Domestic consumption of refined new copper in 1909 and 1910, in pounds.

	1909	1910
Total refinery output	1,391,021,454	1,422,039,135
Stock at beginning of year	121,876,759	141,486,244
Total available supply	1,512,898,213	1,563,525,379
Refined copper exported	682,846,726	[a] 708,316,543
Stock at end of year	141,486,244	122,803,656
Total withdrawn from supply	824,332,970	831,120,199
Apparent consumption	688,565,243	732,405,180

[a] Exports of pigs, bars, ingots, plates, etc., reported by the Bureau of Statistics. The change in this sum from that published in the advance statement, May 29, 1911, is due to a change in the figures of exports as reported by the Bureau of Statistics.

If to the 732,400,000 pounds of new refined copper is added the 189,000,000 pounds of secondary copper and copper in alloys produced during the year, it is found that a total of 921,400,000 pounds of new and old copper was available for domestic consumption.

The following table shows the monthly deliveries of copper for domestic consumption and export as reported by the Copper Producers' Association:

Monthly deliveries of copper for domestic consumption and for export, in 1910, as reported by the Copper Producers' Association, in pounds.

Month.	Domestic consumption.	Export.	Total.
January	78,158,387	81,691,672	159,850,059
February	66,618,322	37,369,518	103,987,840
March	62,844,818	40,585,767	103,430,585
April	67,985,951	31,332,403	99,318,354
May	59,305,222	45,495,440	104,800,662
June	53,363,196	65,895,948	119,259,144
July	56,708,175	59,407,167	116,115,342
August	67,731,271	61,831,780	129,563,051
September	64,501,018	75,106,496	139,607,514
October	67,814,172	68,186,912	136,001,084
November	60,801,992	67,424,316	128,226,308
December	43,594,018	88,104,075	131,698,093
Total	749,426,542	722,431,494	1,471,858,036

It may be noted that the difference in domestic deliveries as shown by the reports of the Copper Producers' Association and those calculated above is due to the fact that the figures of export as reported by the Bureau of Statistics and by the Producers' Association do not agree exactly. The cause of this difference is stated under the discussion of exports.

USES.

No systematic attempt has been made to ascertain the proportion of the copper output of 1910 used in different industries, as electric transmission, brass manufacture, casting, etc. Some idea of the quantities entering the different industries can be gained from the forms in which the output of the refineries was cast. The following table shows the approximate quantity of copper cast in the different forms during 1910 as reported by the refining companies. It will be noted that the total does not equal the refinery output of copper for 1910.

Forms in which copper was cast in 1910, in pounds.

Form.	Total.	Percentage.
Wire bars	720,505,724	50
Ingots and ingot bars	441,302,990	31
Cakes	142,660,100	10
Cathodes	99,500,146	7
Other forms	26,620,036	2
Total	1,430,588,996	100

It may be assumed that a large portion of the 50 per cent cast as wire bars was used for electrical purposes and that the 10 per cent cast as cakes was used largely for rolling. The other forms are less easily classified. The 7 per cent cast as cathodes, together with a portion of the ingots, probably entered the brass industry, and a

large quantity of copper ingots was used in casting. The refinery output for 1909 was cast as follows: Wire bars, 46 per cent; ingots, 25 per cent; cakes, 10 per cent; cathodes, 16 per cent; other forms, 3 per cent.

PRICES.

The average yearly quoted price of electrolytic copper at New York in 1910 was 12.738 cents per pound; in 1909 the price was 12.98 cents per pound. The average monthly prices for electrolytic copper in 1909 and 1910 are given in the following table:

Monthly prices per pound of copper in 1909 and 1910, in cents.

Month.	Price of electrolytic copper, in cents.	
	1909	1910
January	13.893	13.620
February	12.949	13.332
March	12.387	13.255
April	12.562	12.733
May	12.893	12.550
June	13.214	12.404
July	12.880	12.215
August	13.007	12.490
September	12.870	12.379
October	12.700	12.553
November	13.125	12.742
December	13.298	12.581
Average	12.982	12.738

The average yearly price of Lake copper was 13.039 cents. These quoted prices are the basis on which much of the copper is sold by the mines and are used by the United States Geological Survey in calculating the value of both mine and smelter output. It is well known, however, that this average yearly price only approximates the actual average price received for copper sold during the year.

The actual average price received by Michigan companies was 12.993 cents per pound, and such data as are available indicate that the average price received for electrolytic copper was slightly higher than that given in the table.

WORLD'S PRODUCTION.

The smelter production of copper in the world was 1,903,297,003 pounds in 1910, as compared with 1,873,404,407 pounds in 1909. In 1910 the smelter output of the United States was 56.75 per cent of the world's production, as compared with 58.22 per cent in 1909 and with 56.54 per cent in 1908.

The following table shows the world's production, by countries. The figures are those compiled by Henry R. Merton & Co. (Ltd.), of London, reduced to pounds, except that the official figures for the production of the United States and Canada are inserted.

World's production (smelter output) of copper in 1909 and 1910, in pounds.

(Copper extracted from ore or contained in the ore produced.)

Countries.	1909	1910
Germany	50,264,880	55,335,460
England	881,840	1,102,300
Italy	6,172,880	7,275,180
Norway	20,502,780	23,368,760
Austria	3,527,380	4,850,120
Russia	39,682,800	50,044,420
Sweden	4,409,200	4,409,200
Spain and Portugal	116,843,800	112,655,060
Turkey	1,763,680	1,322,760
Hungary	10,361,620	11,023,000
Total Europe	254,410,840	271,386,260
Canada	52,493,863	56,598,074
Mexico	126,103,120	131,614,620
Newfoundland	3,086,440	2,425,060
United States	1,092,951,624	1,080,159,509
Total North America	1,274,635,047	1,270,797,263
Argentina	1,322,760	661,380
Bolivia	4,409,200	5,511,500
Chile	80,247,440	78,924,680
Peru	35,934,980	41,005,560
Cuba	6,613,800	7,716,100
Total Central and South America	128,528,180	133,819,220
Cape Colony	10,361,620	9,920,700
Namaqualand	5,070,580	5,511,500
Other Africa	17,857,260	18,518,640
	33,289,460	33,950,840
Japan	105,379,880	102,954,820
Australia	77,161,000	90,388,600
Grand total	1,873,404,407	1,903,297,003

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